Essays on the Real Effects of Exchange Rate-Based Stabilizations

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Abstract

Exchange rate crises in Latin America recently put a spotlight on the perils of Exchange Rate-Based Stabilizations (ERBS), which use the nominal exchange rate as the main policy target for stabilizing inflation. This dissertation documents the effects of ERBS in high inflation economies and develops models to explain these stylized facts.

The **first chapter** assesses the empirical regularities associated with ERBS. Based on a sample of 13 stabilization episodes, typical real and monetary dynamics are investigated in Burns-Mitchell diagrams. Stylized facts of ERBS are the initial increases in consumption and GDP, the real appreciation and the current account deterioration. Moreover, consumption and output are found to follow a boom-slowdown cycle, where slowdown means reduced or zero growth if the ERBS is still in effect, and negative growth rates for failed ERBS. Capital inflows follow a similar boom-bust cycle: Their increase at the stabilization's inception is followed by a sharp reversal three to six years later, very often coinciding with the program's collapse. This transitoriness of ERBS constitutes an additional stylized fact: 70 % of the programs under consideration failed within 10 years after their implementation.

The origin of the initial real exchange rate appreciation during ERBS has been subject to controversy: Most models assume an increase in the relative price of non-traded goods. Empirical findings, in contrast, emphasize the contribution of traded goods' cross-country prices. **Chapter 2** sheds light on this issue by applying Engel's (1995) method of variance decomposition on Brazilian-US real exchange rate fluctuations. The results confirm both the models and the empirical findings: When considering the full sample (from January 1981 to May 2001), changes in traded goods' prices and the nominal exchange rate account for almost all of the observed real exchange rate movements. During periods of pegged exchange rates, however, non-traded goods' prices are equally important for real exchange rate fluctuations. Thus, changes in relative non-tradables' prices are incorporated as a determinant of real exchange rate fluctuations during ERBS in the theoretical frameworks presented in chapters 3 and 4. These explain the stylized facts in models of small, open economies populated by a utility-maximizing representative agent endowed with perfect foresight. Money matters due to cash-in-advance constraints. Further important features are the existence of market imperfections – price stickiness or imperfect capital mobility – and the stabilization's deficient credibility. In **chapter 3**, the latter is due to the anticipation of a Krugman (1979)-style currency crisis. The initial real appreciation during

ERBS can then be explained with forward-looking price setting by monopolistic non-tradable goods' producers: These are subject to staggered price setting and incorporate the peg's anticipated termination – i.e. higher *future* devaluation rates – by increasing their *current* prices. As tradables' prices are determined by the law of one price, this implies higher relative non-tradables' prices and thus a real exchange rate appreciation. Furthermore, due to intertemporal consumption substitution, the observed initial consumption boom is reproduced. Econometric evidence confirms the proposed price setting mechanism: Using the Mexican-US interest rate differential as an indicator for devaluation rate expectations, OLS regressions with monthly Mexican data find a significant positive relation between relative non-tradables' prices and the interest rate spread during periods of pegged exchange rates.

In the previous model, the stabilization effort collapses due to a fundamental inconsistency between the exchange rate target and government finance. **Chapter 4** shows that the collapse can also result from self-fulfilling expectations. This is achieved by introducing partial international capital mobility. Given this constraint, both the initial consumption boom and the stabilization's collapse can be shown to result from expectations about the duration of the peg and post-stabilization monetary policy.

In conclusion, the dissertation points to the perils of ERBS in high inflation countries: Contrary to what is commonly believed, even relatively successful and long-lived exchange rate pegs are associated with a late slowdown; only very few ERBS are successful at stabilizing inflation rates in the medium and long run. The models show that stabilizations' deficient credibility – regardless if justified by fundamentals or not – engenders real dynamics which distort economic activity and jeopardize the stabilization effort: The miracle of ERBS turns into a mirage.

Keywords:
Exchange Rate Based-Stabilization, Currency Crises, Inflation Stabilization, Emerging Economies

Zusammenfassung

Die lateinamerikanischen Währungskrisen lenkten erst kürzlich wieder das Augenmerk auf die Gefahren wechselkursbasierter Stabilisierungen (WKBS). Dies sind Inflationsstabilisierungsprogramme, die den nominalen Wechselkurs als vorrangiges geldpolitisches Instrument einsetzen. Die vorliegende Dissertation dokumentiert die Wirkung der Stabilisierungen und präsentiert Erklärungsmodelle für deren stilisierte Fakten.

Das **erste Kapitel** untersucht anhand von Burns-Mitchell-Diagrammen typische reale und monetäre Effekte von 13 Stabilisierungsepisoden. Der anfängliche Anstieg des Konsums und des BIPs, die reale Aufwertung und die Verschlechterung der Leistungsbilanz sind dabei die auffälligsten stilisierten Fakten. Auf die Expansion folgt eine wirtschaftliche Abschwächung, d. h. niedrigeres oder Nullwachstum, falls die Stabilisierung noch andauert, und negative Wachstumsraten, falls das Programm bereits aufgegeben wurde. Die Kapitalimporte folgen einem ähnlichen Zyklus: Dem Anstieg zu Beginn der Stabilisierung folgt drei bis sechs Jahre später eine drastische Umkehr, die häufig mit dem Zusammenbruch des Programms einhergeht. Die Kurzlebigkeit von WKBS ist ein weiterer stilisierter Fakt: 70 % der betrachteten Stabilisierungen scheiterten innerhalb von 10 Jahren.

Die anfängliche reale Aufwertung während WKBS wird meist als Anstieg des relativen Preises nicht-handelbarer Güter modelliert; empirische Ergebnisse hingegen unterstreichen die Bedeutung der internationalen Preisunterschiede handelbarer Güter. **Kapitel 2** untersucht diese Ursachen durch die Anwendung von Engels Methode der Varianzzerlegung auf den realen Wechselkurs zwischen Brasilien und den USA. Die Ergebnisse bestätigen dabei sowohl die Modelle als auch den empirischen Befund: Bei Betrachtung der gesamten Stichprobe (von Januar 1981 bis Mai 2001) bestimmen Veränderungen der Preise handelbarer Güter und des nominalen Wechselkurses nahezu die gesamten Bewegungen des realen Wechselkurses. Während Perioden fester Wechselkurse hingegen sind die Preise nicht-handelbarer Güter von ähnlicher Bedeutung. Aufgrund dieses Ergebnisses wird in den in Kapitel 3 und 4 präsentierten

Modellen der reale Wechselkurs in Abhängigkeit des relativen Preises nicht-handelbarer Güter dargestellt. Diese Modelle bilden kleine, offene Volkswirtschaften ab, die von nutzenmaximierenden repräsentativen Agenten mit perfekter Voraussicht bevölkert sind. Monetäre Größen sind aufgrund von *cash-in-advance-* Beschränkungen von Bedeutung. Weitere wichtige Modellelemente sind die Existenz von Marktimperfektionen (Preisstarrheiten und unvollständige Kapitalmobilität) sowie die mangelnde Glaubwürdigkeit der Stabilisierung. In **Kapitel 3** ist diese durch die Antizipation einer Währungskrise à la Krugman (1979) begründet. Die reale Aufwertung kann dann mit vorausblickender Preissetzung der monopolistischen Produzenten nicht-handelbarer Güter erklärt werden: Aufgrund von Preisstarrheiten erhöhen diese ihre Preise in Erwartung der Währungsabwertung. Da die Preise handelbarer Güter durch das Gesetz des einheitlichen Preises bestimmt werden, folgt daraus ein Anstieg des relativen Preises nicht-handelbarer Güter und eine reale Aufwertung. Zudem wird aufgrund intertemporaler Konsumsubstitution der anfängliche Konsumboom reproduziert. Ökonometrische Evidenz bestätigt den Preissetzungsmechanismus: KQ-Schätzungen mit monatlichen mexikanischen Daten zeigen für Perioden fester Wechselkurse einen signifikanten positiven Zusammenhang zwischen dem relativen Preis nicht-handelbarer Güter und dem mexikanisch-US-amerikanischen Zinsdifferential als Approximation der Abwertungserwartung.

Während das Ende der Stabilisierung in obigen Modell durch eine fundamentale Inkonsistenz von Wechselkursziel und Staatsausgaben bedingt ist, zeigt **Kapitel 4**, daß der Zusammenbruch auch aus sich-selbst-erfüllenden Erwartungen resultieren kann. Ein wesentliches Element ist dabei die Begrenzung der internationalen Kapitalmobilität. Diese erlaubt es, sowohl den anfänglichen Konsumboom als auch das Ende der Stabilisierung mit Erwartungen bezüglich der Dauer des Pegs und der nachfolgenden Geldpolitik zu erklären.

Zusammenfassend zeigt die Dissertation die Gefahren wechselkursbasierter Stabilisierungen auf: Im Gegensatz zur herkömmlichen Meinung sind sogar relativ erfolgreiche und langlebige WKBS mittelfristig mit einer Kontraktion verbunden; nur wenige Programme erzielen eine nachhaltige Reduktion der Inflation. Die hier präsentierten Modelle zeigen, daß die mangelnde Glaubwürdigkeit der Programme – selbst wenn diese nicht durch Fundamentaldaten gerechtfertigt ist – zu Allokationsverzerrungen führt und den Erfolg der Stabilisierungsmaßnahmen gefährdet.

Schlagwörter:
Wechselkursbasierte Stabilisierungen, Währungskrisen, Inflationsstabilisierung, Schwellenländer

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Contents

List of Figures

List of Tables

Notation Guide

Common Notation

Throughout the dissertation, the terms ‘tradable’ and ‘traded’ are used interchangeably.

r: Real interest rate
g: Net transfers to private agents

Variables and Parameters in Chapter 3

Lower case letters denote intermediate goods and prices.
Subscripts N and T characterize non-tradable and tradable goods.
Barred variables are constant.

B^* : Foreign bonds
C : Consumption index over tradable and non-tradable goods
C_N: Consumption of the non-tradable final good
C_T: Consumption of the tradable final good
CA: Net imports of goods
E : Nominal exchange rate, in European terms
MC : Marginal cost of producing non-tradable intermediate goods
$p_N(z)$: Price of non-tradable intermediate goods, indexed with z
P: Price level
P_N: Price of the non-tradable final good
P_T: Price of the tradable final good
$\bar{Y}_T$: Endowment of tradable goods
y_N: Supply of non-tradable intermediate goods
Y_N: Supply of non-tradable final goods
Z^{nom} : Total nominal expenditure on consumption

α: Share of firms setting prices in even periods
β: Agent's subjective discount factor
γ: Share of non-tradables consumption in total consumption ($C = C_N^{\gamma} C_T^{(1-\gamma)}$)

λ: Lagrange multiplier
μ: Rate of nominal money growth
θ: Measure of producers' monopoly power
($\frac{1}{1-\theta}$: price elasticity of demand faced by each monopolist)
Φ: Generic constant

s: Time index, $s \in [t, \infty)$
t^*: Period in which stabilization is implemented
$t^* + 1$: Period in which stabilization is abandoned

Variables and Parameters in Chapter 4

Subscripts I and II denote the variables' respective values during the stabilization and post-stabilization period.
Starred variables denote foreign variables.
Assets: The subscript indicates the owner of the asset.

a: Private agents' wealth
b_p^*: Private sector net foreign assets
b_p: Private sector net home assets
b_{CB}^*: Foreign-currency denominated bonds held by the central bank
$\tilde{b}_t^*$: Critical value of foreign borrowing
c: Consumption of the representative agent
E_0: Initial private sector wealth
g: Net transfer to the representative agent
h : Positive constant entering the government's spending rule
i: Nominal interest rate
m: Total real balances
m^{np}: Money held for non-productive purposes
m^p: Money held for productive purposes
m^s: Real money supply
n: Positive constant entering the borrowing constraint
R_{min}: Lower bound on central bank reserves
S: Nominal exchange rate, in European terms
y: Income of a representative agent (=per capita income)
$\bar{y}$: Permanent income

A, B: generic constants

α: Fraction of total consumer expenditure covered with cash holdings
β: Agent's subjective rate of time preference
ε: Rate of devaluation
ε^e: Expected rate of devaluation

κ: Parameter for labor disutility
λ: Costate variable
μ: Lagrange multiplier
ν: Fraction of production covered with cash holdings
π: Inflation rate.
σ: Elasticity of intertemporal substitution
T^*: End of 'stabilization period'
T^{**}: Period in which the critical level of foreign debt is reached

Chapter 1

Exchange Rate-Based Stabilization – The Phenomenon to Be Explained

1.1 Introduction

Great parts of the developing world have been plagued by high and frequently persistent inflation: Inflation rates exceeding 10 percent per annum have been widespread, prolonged inflationary episodes with annual rates above 40 percent not uncommon. In the face of this performance, policy makers did not remain idle: Myriads of inflation stabilization programs were implemented in developing countries. While most of these failed to achieve a sustained decrease in inflation, their real effects defied findings from stabilizing moderate inflation rates: Contrary to conventional wisdom[1], many exchange rate-based inflation stabilizations (ERBS) in developing countries were followed by increases in consumption and output. Systematic research on this phenomenon started in the mid eighties, motivated by the pronounced consumption boom witnessed in the initial stages of exchange rate-based inflation stabilizations in Latin America and Israel. At about the same time, research on historic hyperinflations and their stabilization indicated that high inflation can be halted at little or no output cost.[2] Thus, two independent strands of empirical research evinced that reducing high inflation engenders dynamics which are different to those of stabilizing moderate inflation, and opened the road

[1]See Gordon (1982), Ball (1994) for inflation stabilizations in general, and Detragiache and Hamann (1999) for evidence on the recessionary nature of exchange- rate based stabilizations in industrialized countries.

[2]See for example Sargent (1982a) and Dornbusch and Fischer (1986).

for research on the real effects of ERBS in high inflation countries.

This dissertation contributes to empirical and theoretical aspects of this research. In a first step, I analyze the empirical regularities associated with ERBS in high inflation economies. Based on a sample of 13 stabilization episodes, typical real and monetary dynamics during stabilization are investigated. Even though this dissertation focuses on ERBS, section 1.4 presents empirical regularities of money-based stabilizations, extracted from a sample of nine stabilizations, as a reference case.

One stylized fact of ERBS found in the cross-country analysis is that the real exchange rate typically appreciates during stabilization. The origin of the real exchange rate appreciation, and generally real exchange rate fluctuations in Brazil, is assessed in Chapter 2. In particular, the contribution of domestic relative non-tradables' prices to real exchange rate fluctuations is quantified.

The next step consists of explaining the observed empirical regularities: The analysis presented in Chapter 3 proposes an explanation for the observed real exchange rate and consumption dynamics during transitory ERBS. It is verified empirically with Mexican data. The model presented in Chapter 4 offers a joint explanation for both the initial dynamics of ERBS and its collapse in a currency crisis.

1.2 What Is Exchange Rate-Based Stabilization?

This section presents definitions of technical terms and conventions recurrently used in this dissertation. A central term to define is 'exchange rate-based stabilization'. Exchange rate-based stabilization (ERBS) denotes an inflation stabilization program which uses the nominal exchange rate (versus a stable currency) as the main policy target. A policy alternative consists in targeting nominal money supply directly, denoted as 'money-based stabilization' (MBS).

Similarly to direct money targeting, fixed exchange rates take the power of printing money out of the central bank's hands: The supply of domestic currency is constrained to a level compatible with the nominal exchange rate target: The nominal exchange rate is the relative price of the foreign currency: It states how many units of the domestic currency must be paid in order to acquire one unit of the foreign currency.[3] The relative price of the foreign currency is determined by the demand for and the supply of the foreign currency relative to demand for and supply of the domestic currency.

[3] This is based on a nominal exchange rate expressed in 'European terms'.

The central bank must adjust its supply of domestic and foreign currency such that the nominal exchange rate target is met. During a fixed exchange rate regime, that is, when the relative price of the foreign currency is set exogenously, the central bank has to supply exactly the amounts of home or of foreign currency such that the foreign exchange market clears at the targeted rate.

This mechanism limits the monetization of government debt, that is, the central bank's acquisition of government debt with newly issued money, which is virtually always at the root of developing countries' inflation.[4]

Why do policymakers recur to printing money for financing government expenditure which must be followed by elaborate programs to stabilize the resulting inflation rates later on?

> "[G]overnments, unable or too timid or too short-sighted to secure from loans or taxes the resources they required, have printed notes for the balance"

is the answer provided by Keynes (1919) in the aftermath of World War I, an answer which still contains much truth for developing countries. In many of these, weak governments recur to printing money instead of consolidating the government's budget, thus evading prolonged political battles over the distribution of the fiscal adjustment.[5] Indexation mechanisms and backward-looking expectations then contribute to the persistence of inflation, and temporary shocks send it off to high levels. When their toll on economic activity becomes sufficiently large, inflation stabilization programs are implemented. As described above, these are designed to tame the fiscal authority's grip on the central bank by putting the country's monetary policy, in effect, on 'autopilot'. There is, however, some scope regarding the roughness of the auto-piloted ride of exchange rate pegging: ERBS can consist of anything between a 'crawling peg', that is, a system of pre-announced currency depreciation, and a currency board. The latter denotes a permanently fixed exchange rate system in which the central bank is obliged to back the private sector's domestic currency holdings with a designated 'hard' currency.[6]

[4] Proceeds from money creation, denoted as seignorage, can be decomposed into two sources: First, the change in the economy's real money holdings and, second, the capital loss inflation inflicts on holders of real monetary balances and government debt, if its value is not inflation-indexed.

[5] Accounts of seignorage-finance in developing countries, the resulting inflation crises and their stabilization can be found in Sachs (1987) and Kiguel and Neumeyer (1995).

[6] At least in theory. The permanency of currency board arrangements is disproved by the recent events in Argentina. See Hanke and Schuler (1994) for aspects of currency board design, and Ghosh et al. (2000) for an evaluation of the recent experience with currency boards.

Pegs can be accompanied by price and income policies, that is, legal ceilings on price and wage increases. Programs making use of such controls are denoted as 'heterodox stabilizations', in contrast to 'orthodox programs' which rely exclusively on the exchange rate anchor and monetary contraction for stabilizing inflation (Kiguel and Liviatan, 1992).

This dissertation considers all these forms of exchange rate management as ERBS. The term 'managed exchange rate' is defined to encompass all systems of exchange rate pegs, including currency boards.

For the empirical analysis of the stylized facts of ERBS and MBS, stabilization episodes must be identified. This requires two conditions to hold: First, the inflation stabilization programs must be based on a single unequivocally detectable nominal anchor. For some programs, this fails to be true: Stabilization efforts in Turkey (1980 and 1998), the Slovak Republic (1991), and Uruguay (1990), for example, comprised targets for both money growth and the exchange rate. This dissertation follows the classification in the IMF's *Economic Outlook* (May 2001). Programs not considered therein are denoted ERBS when an exchange rate peg was part of the IMF's stabilization package at the time the inflation rate was reduced.[7] The second condition for an empirical analysis of stabilization programs is that their beginning and termination must be identifiable. This is the case for most ERBS, as their start and end coincides with what is officially announced. Some programs, however, seem to be characterized by a continuum between 'stabilization' and 'abandonment of stabilization'. The Brazilian real stabilization, for instance, entailed a one-to-one peg of the Brazilian real to the US dollar (from July 1994 to February 1995), a one-time devaluation of five percent in March 1995, and a five percent exchange rate fluctuation band thereafter. Even though the peg was officially abandoned in January 1999, the maximum monthly devaluation rate since March 1999 amounts to a mere five percent. This illustrates that the anti-inflationary stance can vary considerably during the course of an officially announced episode of ERBS and that the official discontinuation of an exchange rate peg does not always imply the end of stabilization-oriented monetary policy and the return of inflation. Easterly (1996) therefore proposes a result-based approach for identifying episodes of inflation stabilization. According to this, inflation stabilization starts when the inflation rate falls by a specific amount, or below a particular threshold. Analogously, the end of stabilization[8] can be defined to occur when the inflation rate increases by a specific amount. It should be noted, however, that

[7]This information is taken from Hamann (2001).

[8]Whenever the term 'stabilization' is used in the following, the stabilization of high inflation rates is referred to.

this criterion does not distinguish between money-based, exchange rate-based and so-called 'populist stabilizations' which produce lower inflation by imposing legal ceilings on price increases.[9] Therefore, this dissertation employs the announcement-based definition of stabilization.

So far, the terms 'high inflation', 'hyperinflation' and 'chronic inflation' have not been quantified. Indeed, no precise quantitative definition exists for these terms. Agenòr and Montiel (1996:265) denote annual average inflation rates exceeding 25 percent as 'high inflation', Easterly (1996) and Hamann (2001) rates above 40 percent. Hyperinflation has been defined as monthly inflation in excess of 50 percent (Cagan, 1957). The term 'chronic inflation' was introduced by Pazos (1972) to denote high and persistent inflation, without providing an exact quantification. This dissertation follows Agenòr and Montiel and considers rates in excess of 25 percent p. a. as high inflation. The term 'moderate inflation' is used to denote inflation rates which are high by industrial countries' standards, but which remain below 25 percent. The label 'chronic inflation' is applied to countries which have been characterized by annual inflation rates in excess of the two-digit level for at least one decade, as for example Argentina, Brazil, Uruguay and Turkey. While most of the empirical research on ERBS has concentrated on the real effects of stabilizing chronic inflation (see Calvo and Végh, 1999), the focus of this dissertation is on stabilizing high inflation in general. A crucial feature of the models presented in chapters 3 and 4, however, is the perceived transitoriness of stabilization, that is, agents' belief that the reduction of inflation and devaluation rates is only temporary. This lack of credibility is a likely fate of inflation stabilization efforts in chronic inflation countries, where a prolonged fight against inflation lead to myriads of unsuccessful stabilization programs, likely to render any additional stabilization effort ex ante non-credible.

Within the paradigm of rational expectations, two types of explanations can be advanced why agents expect stabilization to be temporary: Agents' expectations can be based on fundamental factors: Agents know that a stable devaluation and inflation rate can only be upheld if it is compatible with fiscal policy in the sense that the latter does not build up pressure to increase seignorage revenues.[10] When agents observe unsustainable spending policies during stabilization, they rightfully anticipate that the ERBS is of transitory nature. Other models view agents' expectations about a peg's sustainability as, to a certain extent, arbitrary. This is compatible with rational expecta-

[9] The term 'populist stabilization' was coined by Agenór and Montiel (1996:267).

[10] This has been shown in the seminal model by Krugman (1979); a further contribution is due to Flood and Garber (1984). Motivated by the Asian currency crises, recent variants focus on *future* government liabilities implied by implicit bailout guarantees, as for example Krugman (1999), Corsetti et al. (1996), or Burnside et al. (2001).

tions only if the occurrence of a devaluation crisis is itself to a certain extent arbitrary, that is, if agents' expectations – and not fundamental factors – ultimately cause the currency crisis. Such mechanisms have for example been proposed by Obstfeld (1986, 1994, 1996), Dellas and Stockman (1989), and Cole and Kehoe (1996) .[11] Whether currency crises are ultimately caused by fundamentals or self-fulfilling elements is subject of ongoing research.[12] This dissertation takes the view that both can be at the root of a currency crisis – no crisis is identical to the next, and different crises have different origins. Therefore, chapter 3 incorporates a fundamentals-driven crisis, whereas chapter 4 proposes a self-fulfilling variant.

The remainder of this chapter serves various purposes: It presents 'what is to be explained', that is, the stylized facts of ERBS. Section 1.3 extracts these from the relevant literature and from data analysis along the lines proposed by Burns and Mitchell (1946). As a reference case, section 1.4 presents the stylized facts of MBS. In a next step, existing explanations of the stylized facts of ERBS are surveyed in section 1.5. Section 1.6 then indicates the gap between 'what is to be explained' and 'what is explained' and motivates the research presented in the Chapters 2 to 4 of this dissertation.

1.3 The Stylized Facts of ERBS

1.3.1 The Empirical Literature

The conventional view of contractionary inflation stabilization was challenged in the late seventies, when major inflation stabilization programs in chronic inflation countries were accompanied by a sharp rise in consumption and a more moderate expansion of GDP. Subsequent research aimed at assessing whether the consumption boom is a common pattern of ERBS and what other stylized facts of stabilizing high inflation exist. Most contributions in this field give qualitative accounts of how real and monetary variables evolve during (officially announced) stabilizations of chronic inflation, as for example Végh (1992), Calvo and Végh (1994a), and Kiguel and Liviatan

[11] Models of self-fulfilling currency crises have recently come under scrutiny, as Morris and Shin (1998) show that when introducing imperfect information about fundamentals and other agents' beliefs, a currency crisis occurs at a unique level of fundamentals. However, this result holds only under particular assumptions about each agent's information set, and thus does not generally disprove the idea of self-fulfilling currency crises.

[12] See for example Krugman (1996) for a critical review of models of self-fulfilling currency crises.

(1992, 1995).[13] Based on 14 ERBS, namely, stabilizations in Argentina (1967, 1978, 1985), Brazil (1964, 1978), Chile (1970, 1973, 1978, 1985), Israel (1985), Mexico (1987), Peru (1986), and Uruguay (1968, 1978), these case-studies characterize ERBS by the following features:

1. ERBS is accompanied by an initial increase in consumption and GDP growth, followed by below-average growth. The cyclical movements of consumption are especially pronounced and occur regardless of the program's sustainability and its medium run effect on inflation.

2. The inflation rate converges only slowly to the level of the devaluation rate, engendering an appreciation of the real exchange rate: During the ERBS considered by Calvo and Végh (1994a), for instance, the annual inflation rate exceeds the devaluation rate by an average 20 percent in the quarter preceding the program's termination, that is, three to four years after its implementation.

3. The current account deteriorates during ERBS, frequently culminating in current account deficits of more than 4 percent.

These features have been dubbed the 'stylized facts of ERBS'. Their robustness can be questioned on several grounds: Derived from qualitative surveys of a small number of individual stabilization episodes in countries with similar characteristics – mostly Latin American chronic inflation countries – a sample selection bias cannot be ruled out. Furthermore, the informal analysis does not allow for testing the *statistical* significance of the observed dynamics. The coincidence of above-mentioned real fluctuations with exchange rate based inflation stabilization does not necessarily imply causality – the observed cyclical movements might as well be due to other factors. Moreover, data precision is deficient for many stabilization episodes.

The first of these caveats is addressed by Easterly (1996). He compiles a larger and more heterogenous sample of inflation stabilizations by applying a result-based criterion: Stabilization is defined to take place when an inflation rate which exceeded 40 percent for at least two years falls below 40 percent and remains there for a minimum of two years. This generates a sample of 28 money- and exchange rate-based inflation stabilizations. Easterly then constructs cross-country averages for relevant variables over these stabilization episodes.[14] An informal analysis of these averages indicates that both

[13] A summary of these publications and the variables considered therein can be found in appendix 1.7.3.

[14] He computes cross-country stabilization-time averages over each of the seven years preceding stabilization, the year of stabilization and each of the following seven years.

ERBS and MBS are typically followed by positive GDP growth. Likewise, consumption rises: Average consumption growth reaches its maximum in the second year after the start of stabilization, but remains positive throughout the seven-year window. Thus, in contrast to the case studies, Easterly does not find a stabilization-induced boom-*recession* cycle, but only the expansion.

Hamann (2001) extends Easterly's analysis in two directions: First, he considers a greater array of variables, and, second, he constructs separate stabilization-time medians over episodes of ERBS and MBS.[15] He finds that the maximum of median GDP growth across his sample of 13 ERBS occurs two years after stabilization was implemented. Median consumption growth exceeds its stabilization-year value by almost two percent throughout the ensuing three years. Investment, in contrast, is not found to rise. The other results confirm the case-study literature: The current account deteriorates – the current account deficit-to-GDP-ratio is up to four percentage points higher than at the onset of stabilization – and the real effective exchange rate appreciates during stabilization.

In sum, the contributions of Easterly and Hamann confirm the initial expansion of GDP and consumption during ERBS. However, they do not find evidence for the late recession identified by the case-study literature. Easterly (1996:91) concludes:

> "It is certainly plausible that there is a boom-recession cycle associated with unsustainable exchange rate pegs. But in this paper's scheme of chronicling post-stabilization years in which inflation remains under control, there is no evidence for a late recession or even a growth slowdown in either exchange-rate based or money-based stabilizations."

This claim will be further assessed in the empirical analysis presented in the next section.

Due to data shortages, the statistical significance of the stylized facts of ERBS has scarcely been formally tested. An exception is the publication by Calvo and Végh (1999), who use data on a panel of four chronic inflation countries[16], and capture the effect of stabilization with an 'early stabilization' and a 'late stabilization' dummy. The 'early stabilization' dummy assumes a value of one during the first three years following the peg's implementation, the 'late stabilization' dummy equals one in the fourth and fifth year. In separate regressions of GDP, private consumption, durables' consumption,

[15] In contrast to Easterly, who presents arithmetic means over stabilization time, Hamann calculates only medians and the associated 95 %-confidence intervals.

[16] Annual data from 1978 to 1993 for Argentina, Chile, Israel and Uruguay is employed.

investment and public consumption on OECD countries' GDP, the Libor rate and the dummies, the 'early' dummy is found to be significant and positive in the regressions explaining GDP, overall consumption, and durables consumption growth. The 'late' dummy is significant and negative in regression with the aforementioned endogenous variables and public consumption. Calvo and Végh interpret these results as a confirmation of the boom-recession cycle in ERBS. However, the findings might be biased due to omitted variables – the authors include few explanatory variables and do not report if the dummies' coefficients are robust when including additional regressors. Furthermore, pegs in the chronic inflation countries under consideration are typically short-lived, such that the late recession might capture the effect of the pegs' collapses.

Calvo and Végh's finding with regard to durables consumption confirms De Gregorio's et al. (1998) informal assessment of durables consumption during seven ERBS in Latin America and Israel. While it is highly plausible that durable goods should play an important role for the consumption boom and current account deterioration during ERBS, publicly available data on durables is too scarce as to quantify their importance for a broader set of stabilizations.[17]

Other empirical studies underline the importance of credit to the private sector for the post- stabilization boom. Based on a panel of Chilean, Mexican, Argentinean and Israeli data, Khamis (1996) finds that inflation stabilization is associated with an increase in real credit to the private sector. Copelman (1996) presents further evidence that liquidity constraints were relaxed during the Mexican stabilization of 1988, and, to a smaller extent, also during the ERBS in Chile (1978) and Israel (1985).[18]

Some of the above-cited case study surveys additionally consider real interest rate, real wage and employment dynamics during stabilization. However, these variables do not seem to follow a common stabilization-time cycle: While real interest rates were reduced during the most crawling pegs of the seventies,[19] Végh's (1992) and my own data analyses do not find a common stabilization-time pattern during more recent episodes. Likewise, while

[17]Burda and Gerlach (1992) emphasize the effect of intertemporal price changes on demand for durables. They find that a large fraction of the US trade deficit during the eighties was due to imports of durable goods. Similarly, De Gregorio et al. (1998) report a pronounced increase in sales of – typically imported – cars during ERBS in Uruguay and Argentina.

[18]Furthermore, Calvo and Coricelli (1993) point out the credit contraction witnessed in Eastern European economies during the transition from plan to market economy as a major determinant of the output contraction.

[19]See for example Corbo (1985) for the Chilean case.

most stabilizations during the sixties and seventies, as well as stabilizations in Brazil (1992) and Mexico (1988), are characterized by real wage increases (Kiguel and Liviatan, 1992), the currency board in Argentina (1991) was accompanied by falling real wages. Evidence on employment is not reported in the literature.

Recapitulating, the following features of ERBS are widely supported by the empirical research:

1. Inflation reduction is initially accompanied by a strong increase in consumption and a more moderate rise in GDP.

2. Investment is not affected by inflation stabilization.

3. The inflation rate is slow to converge to the devaluation rate, and the real exchange rate appreciates.

4. The current account deteriorates.

Other features have been derived from samples which are too small to trust their robustness: We do not know if the expansion in credit to the private sector during stabilization is really a *general* characteristic of ERBS, and whether it coincides with the rise in consumption. Employment dynamics during stabilization have hardly been assessed so far. Furthermore, lacking data precludes an assessment of how much of the consumption boom is due to durables consumption. Other alleged stylized facts are controversial: Is ERBS really followed by a boom-*recession* cycle, or just positive output and consumption growth? Is the late recession an exclusive characteristic of *transitory* stabilizations? Is the consumption boom particularly pronounced for non-credible stabilizations, as commonly claimed?[20] The next section aims at answering some of these questions by providing additional evidence on the real and monetary dynamics associated with ERBS.

1.3.2 The Empirical Analysis

The previous section showed that the literature on the stylized facts of ERBS comprises case study surveys (Végh, 1992; Kiguel and Liviatan, 1992, 1995; Calvo and Végh, 1994a), cross-country averaging over stabilizations (Easterly, 1996; Hamann, 2001) and a regression analysis for chronic inflation countries (Calvo and Végh, 1999). Caveats apply to all of these approaches: Case studies focus on a small number of stabilizations of chronic inflation and are

[20] See for example Velasco as cited in Easterly (1996:104), or Alfaro (1999:216) .

thus likely to exhibit a sample selection bias. Averaging over stabilization-time implies a significant loss of information, as large standard errors reveal that individual stabilizations diverge strongly from the average profile. Viñals (1996:101), for instance, criticizes Easterly's analysis of averages on the grounds that based on an analysis of individual stabilization episodes, "a short-run worsening of output conditions happened more often than the means and medians presented in the figures lead us to believe", namely, in 10 out of the 28 stabilizations considered. Similarly, regression results might be driven by these 'outliers'.

The analysis presented in what follows is closely related to the empirical work by Hamann (2001). Hamann considers 13 ERBS, and presents medians and confidence intervals for 9 variables[21] during stabilization, that is, over an interval of six years, centered around the inflation rate reduction brought about with ERBS. To my knowledge, it constitutes the only assessment of the stylized facts of ERBS which is based on a sample of more than 10 stabilization episodes.[22] However, Hamann's investigation leaves some questions unanswered: The 95% confidence intervals presented are very wide – for example, they indicate a lower and upper bound for real per capita GDP growth of -3 and +5.8 percent in the year the inflation rate is first reduced; for per capita consumption growth 2 years after stabilization, the confidence bands assume values of -5 and over +5 percent. As the medians are not complemented by data on individual stabilization episodes, this leaves some doubt if common empirical regularities of ERBS exist at all. Moreover, it is not reported what happens after the three post-stabilization years, which precludes an assessment of the differences between successful and unsuccessful stabilizations. As Hamann's main objective is comparing the real effects of exchange rate and money-based stabilizations, in particular their effect on GDP growth, many variables of interest, as for example credit to the private sector, employment and capital imports, are not considered.

My analysis follows Hamann in presenting stabilization-time medians. These are complemented with the respective variables' means, with data on the individual stabilization episodes under consideration, and correlations of relevant variables. While these approaches are not novel – and, as pointed out, not immune to criticism – their combination renders the analysis of the stylized facts of ERBS more transparent and provides more evidence on their robustness. As in Easterly (1996) and Hamann (2001), central elements of

[21]The variables under consideration are inflation, growth of M2, central government balance, GDP growth, consumption growth, investment growth, current account, the real effective exchange rate, and gross international reserves.

[22]Recall that Easterly's analysis does not systematically distinguish between the effects of MBS and ERBS.

my analysis are 'stabilization-time diagrams' in the spirit of the business cycle profiles proposed by Burns and Mitchell (1946). I compute cross-country means and medians over 'stabilization time', whereby the 'year of stabilization' or 'year 0' is defined as the year the exchange rate peg was officially announced (if it was implemented within the first six months of the year), or the following year if the peg began during the last six months.[23] Then, data on a particular variable during each of the six years preceding the year of stabilization, the year of stabilization itself, and the following seven years is averaged across stabilization episodes. This yields the variable's typical 'stabilization sequence'.[24]

The sample under consideration includes all major ERBS during the past 25 years, except those in transition economies.[25] The classification of 'major ERBS' is based on two sources: The IMF's listing of "Major Emerging Markets Exchange-Rate and Money-Based Stabilization Programs since the 1970s" in a recent issue of the *World Economic Outlook* (2001:136, Table 4.4). Of the ERBS listed therein, only the programs in Turkey (1998) and Argentina (1978) are excluded, since it is debatable if the former really constituted an *exchange rate*-based stabilization (see Dibooglu and Kibritcioglu, 2001), and IFS data on the latter is associated with large measurement errors. The second point of reference is the publication by Hamann (2001), which identifies 51 inflation stabilization episodes, among them 13 ERBS, by applying a data-based criterion.[26] Of these, I exclude the stabilizations prior to 1970, namely, the ERBS in Brazil, 1966, and Uruguay, 1969, and the Nicaraguan (1990) stabilization due to a lack of reliable data, and the reduction in the Argentinean inflation rate in 1980, since it is not mentioned as *exchange rate*-based stabilization in the literature. Table 1.1 summarizes the resulting 13 stabilization episodes of my sample.

Extracting stylized facts of ERBS from this sample complements the ex-

[23]Whenever the 'mean' is mentioned in the following, it is the arithmetic mean I refer to. It is defined as the sum of a list of numbers, divided by the total number of numbers in the list. The median is the 'middle value' of a list, the smallest number such that at least half the numbers in the list are no greater than it. If the list has an odd number of entries, as for this analysis of 13 stabilization episodes, the median is the middle entry in the list after sorting the list into increasing order. If the list has an even number of entries, the median is equal to the sum of the two middle (after sorting) numbers divided by two.

[24]Given the small sample size, standard error bands are not reported.

[25]An analysis of exchange rate regimes during transition raises general issues related to transition strategies and their real effects which are beyond the scope of this study. The interested reader is referred to Fischer, Sahay and Végh (1996), Sachs (1996) and Sahay and Végh (1996) for an overview of transition economies' experience.

[26]Stabilization is defined to occur when the inflation rate is lowered by at least 1/4 the first year and remains below its pre-stabilization level for at least another year.

Country	Starting Date	Program Design	Did program end in crisis?
Argentina Austral	June 1985	Heterodox peg, crawling peg	Yes (September 1987)
Argentina Peso	1.4.1991	Currency board with one-to-one parity to the US dollar	Yes (January 2002)
Brazil Cruzado	28.2.1986	Heterodox peg	Yes (March 1987)
Brazil Real	1.6.1994	One-to-one peg to the US dollar	Yes (January 1999)
Chile	Feb. 1978	Crawling peg, peg	Yes (February 1983)
Ecuador	July 1992	Peg to the US dollar	Yes (1998/99)
Egypt	8.10.1991	3 percent fluctuation band vis-á-vis the US dollar	No
Peru	1985/86	Heterodox ERBS with multiple fixed exchange rates	Yes (1987)
Iceland	1982	Crawling peg	Yes (1988)
Israel	July 1985	Peg, horizonal band, crawling band	No (but jump in the devaluation rate in 1989)
Mexico	December 1987	Peg, crawling peg, widening band	Yes (December 1994)
Uruguay	October 1978	Pre-announced crawling peg	Yes (December 1982)
Uruguay	December 1990	Exchange rate band with declining rate of devaluation	Yes (July 2002)

Table 1.1: Episodes of ERBS

Notes: A crisis is defined to occur when the exchange rate devalues and central bank reserves fall. Most crisis dates are taken from the IMF World Economic Outlook (2001:136).

isting literature in several respects: In contrast to the case study literature, it includes recent stabilizations, and does not exclusively focus on chronic inflation: The sample includes stabilizations of chronic inflation, hyperinflation and 'one-time-high' inflation. Furthermore, while Easterly (1996) focuses on successful stabilizations, my sample includes highly transitory stabiliza-

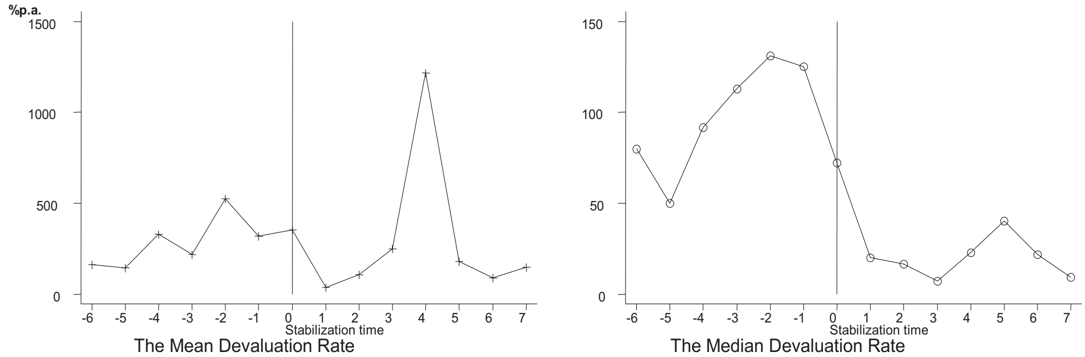

Figure 1.1: Devaluation rates during stabilization

tions.[27] All data is from the IMF's *International Financial Statistics* (IFS) database; a detailed description of the data is presented in appendix 1.7.3 to this chapter.

Figure 1.1 presents the stabilization-time profiles of the mean and the median devaluation rate. The devaluation rate is calculated as the annual percentage growth of the nominal exchange rate in 'European terms', that is, defined as the units of the stabilizing economy's currency required to purchase one US dollar. The horizontal line marks the year in which the exchange rate peg was officially announced, that is, the 'year 0' in stabilization-time. On the left of year 0, data for the six years prior to the official announcement of stabilization are reported, on the right for the seven years after stabilization.

Both devaluation rate measures start decreasing before that year – their maximum values are reached two years before the official start of stabilization. The magnitude of the devaluation rate reduction is considerable: Between stabilization-time years -2 and +1, the mean devaluation rate is reduced from 524.27 to 37.31 percent; the median devaluation rate from 131.28 to 20 percent; the decrease during the first year of stabilization amounts to 317 and 52 percentage points, respectively. The rise of the median devaluation rate in the fifth year after the peg's inception reflects the transitory nature of many stabilizations – eight out of the 13 episodes under consideration have been abandoned by that year. Differences between mean and median devaluation rates are chiefly due to the 'hyperdevaluations' in the aftermath of the Argentinean, Brazilian and Peruvian stabilizations of the eighties.

Figure 1.2 presents mean and median inflation rates. Their paths are sim-

[27] Recall that Easterly considers only episodes where the inflation rate remained below forty percent for at least two years.

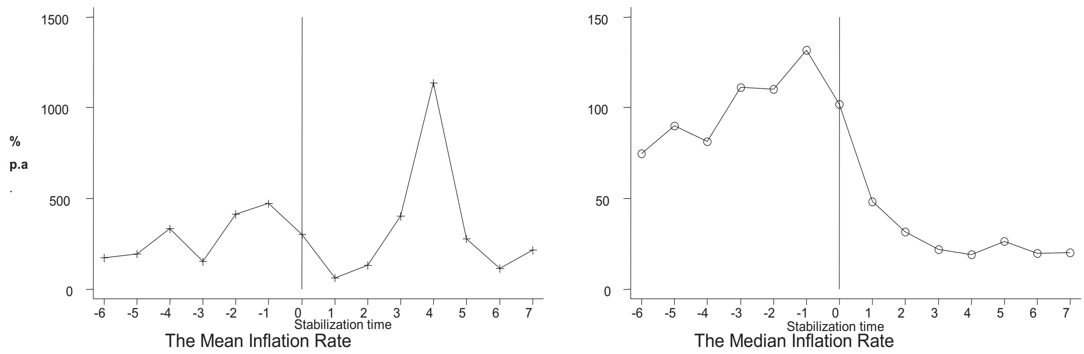

Figure 1.2: Inflation rates during stabilization

ilar to the mean and median devaluation rate paths. Their pre-stabilization maxima are reached in the year preceding the official announcement of ERBS. The magnitude of the inflation decrease falls short of that of the devaluation rate: During the years -1 through 3, the median inflation rate exceeds the median devaluation rate (see figure 1.3). Two years after the implementation of stabilization, the difference between mean devaluation and inflation rates still amounts to 24 percent. Even stabilizations of hyperinflations in Argentina (1991), Brazil (1994) and Nicaragua (1990) did not achieve a sudden stop: Although inflation rates are considerably reduced during the first year of stabilization, it takes an additional year to bring them down to around 20 percent (see table 1.2). This stands in contrast to historic episodes of stabilizing hyperinflations– Dornbusch and Fischer (1986:8), for instance, report on the German hyperinflation of 1923: “The reform took hold immediately. Prices stopped rising virtually at once.”

Period	Average Inflation Rate (percent p.a.)
Pre-stabilization (average of the 2 years preceding stabilization)	1334.09
Year of stabilization (=Year 0)	391.37
Post - stabilization short run (average of the 2 years following year 0)	27.86
Post - stabilization long run (average of stabilization-time years 3 and 4)	17.11

Table 1.2: Inflation rates during stabilizations of three hyperinflations

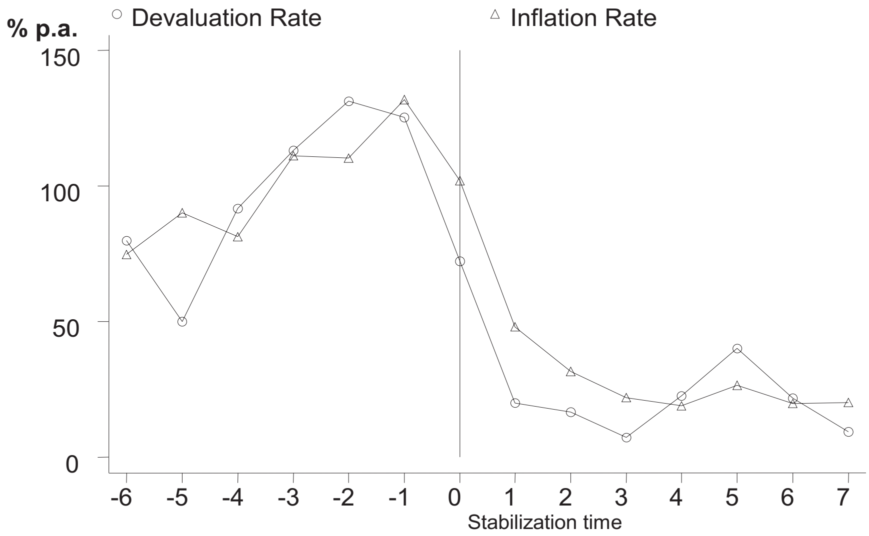

Figure 1.3: Median devaluation and inflation rates during stabilization

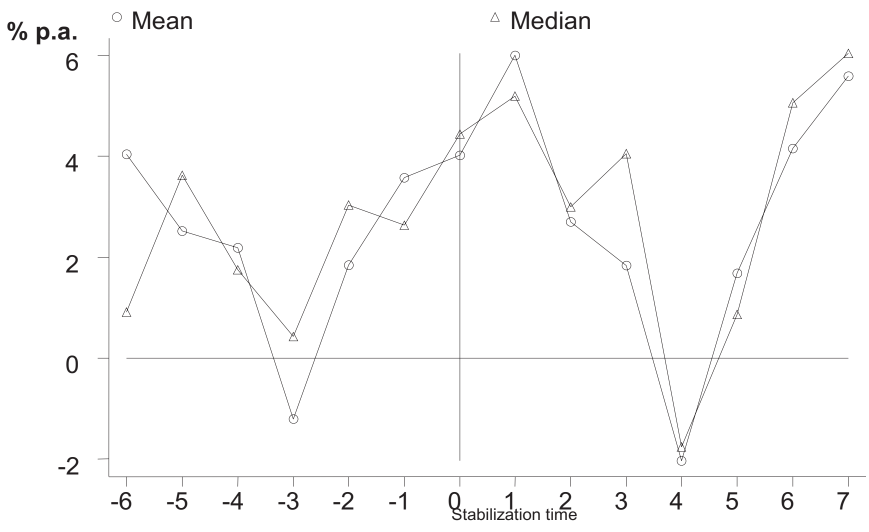

Figure 1.4: GDP growth during stabilization

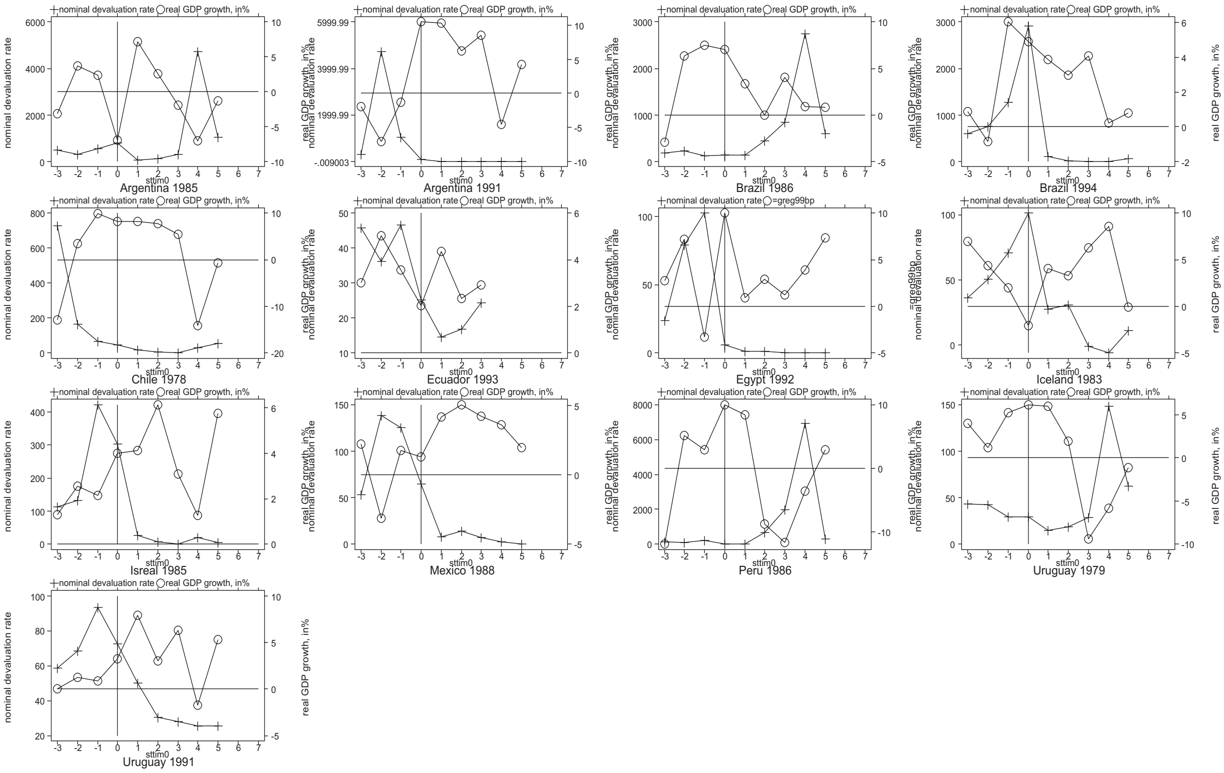

Figure 1.5: GDP growth during the individual stabilizations

What are the *real effects* of inflation stabilization? Figure 1.4 confirms the expansionary nature of ERBS: Mean and median GDP growth increase as the devaluation rate falls, that is, before the official announcement of ERBS. Figure 1.5 confirms this pattern for each of the individual stabilization episodes: With the exception of the 1994 stabilization in Brazil, the increase in GDP typically coincides with the devaluation rate reduction. The data on the individual stabilizations reveal that some stabilizations are characterized by extremely high growth rates. GDP growth in Argentina (1991), Egypt (1992), and Peru (1986), for example, reaches rates of almost 10 percent in the year of stabilization. In my opinion, this is, more than anything else, a reminder that the data quality might be deficient in the sense that reported GDP (and consumption) might exceed actual outcomes in some countries.[28] Furthermore, the expansionary effect of stabilization might be overstated as entrepreneurs and consumers move from the informal to the formal sector as the inflation rate falls and the economy stabilizes. However, even when accounting for the suspicion that particular numerical values might not be entirely accurate, the data on the individual stabilizations and median GDP growth evinces that the reduction in the devaluation rate is accompanied by an increase in GDP.

Figures 1.4 and 1.5 show that mean and median GDP follow a pronounced boom-*recession* cycle, as suggested by the early literature on the stylized facts of ERBS. Is the recession a consequence of stabilizations' breakdown, or is it a general feature of ERBS? As a first pass at the data, correlations of the devaluation rate and GDP growth during stabilization-time years 1 to 4 are computed for each individual stabilization episode. This yields an average correlation of -0.18. A 'naive' interpretation of this is that a 10 percent devaluation rate increase reduces GDP by 1.8 percent; naive, because it neglects that the correlation does not allow to conclude about causality: Policymakers might abandon stabilizations associated with low output, such that the recession causes the devaluation, and not vice versa. Also, the recession and devaluation might both stem from a common third cause.[29] For further evidence, I check if the recession occurs also during the six episodes which are not followed by a devaluation crisis within the seven post-stabilization years under consideration. Of these, the ERBS in Argentina (1991), Chile

[28]*The Economist* (2002, No.8254:32), for instance, questions the accuracy of official Egyptian data on GDP and the government deficit. A detailed treatment of shortcomings of developing economies' data measurement is presented by Heston (1994).

[29]That low growth causes the devaluation can be explained by models which incorporate a policy maker's loss function which contains the inflation or devaluation rate and output as arguments (see Obstfeld, 1994) . An example for a possible third cause is an exogenous terms-of-trade shock, which reduces GDP through lower exports, and induces the policymaker to devalue in order to boost the country's international competitiveness.

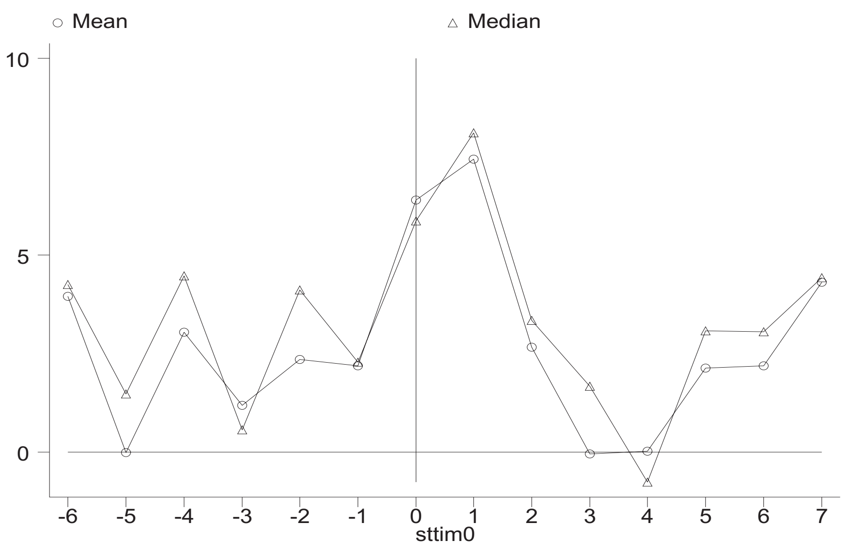

Figure 1.6: Consumption growth during stabilization

(1978), and Uruguay (1991) are accompanied by negative GDP growth in the fourth or fifth year after stabilization;[30] the Brazilian (1994), Israeli and Mexican stabilizations are characterized by positive, but considerably lower GDP and consumption growth during these years.This suggests that a (temporary) slowdown of GDP growth four to five years after the implementation of stabilization is a general characteristic of ERBS, regardless of their duration.

Figure 1.6 presents the mean and median values of consumption growth. Consumption follows a boom-bust cycle similar to GDP and starts rising in the year stabilization is implemented. Figure 1.7 graphs the devaluation rate and consumption growth for each stabilization episode. With the exception of the Chilean (1978) stabilization, the programs are associated with a pronounced increase in consumption growth between periods -1 and 0 or 0 and 1. Similarly to what was found for GDP, the data reveal extreme consumption fluctuations and high growth rates, which suggests some data mismeasurement. Kydland and Zarazaga (1997:25), for instance, point out that Argentinean consumption is computed as a residual, which might account for some of the extreme values.

Figure 1.8 presents the consumption-to-GDP ratio. As pointed out in the literature,[31] the post-stabilization increase in consumption exceeds GDP growth.

[30]The Uruguayan stabilization is additionally followed by negative GDP and consumption growth two years after its implementation.

[31]For example Kiguel and Liviathan (1992), or Végh (1992) .

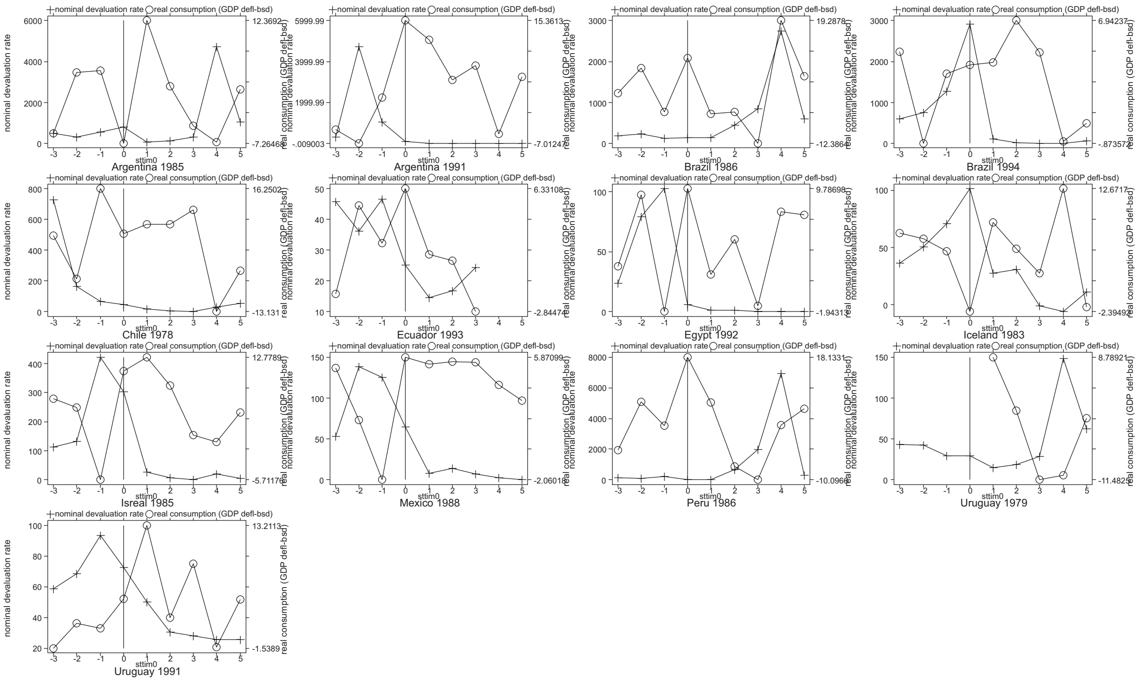

Figure 1.7: Consumption growth during the individual stabilizations

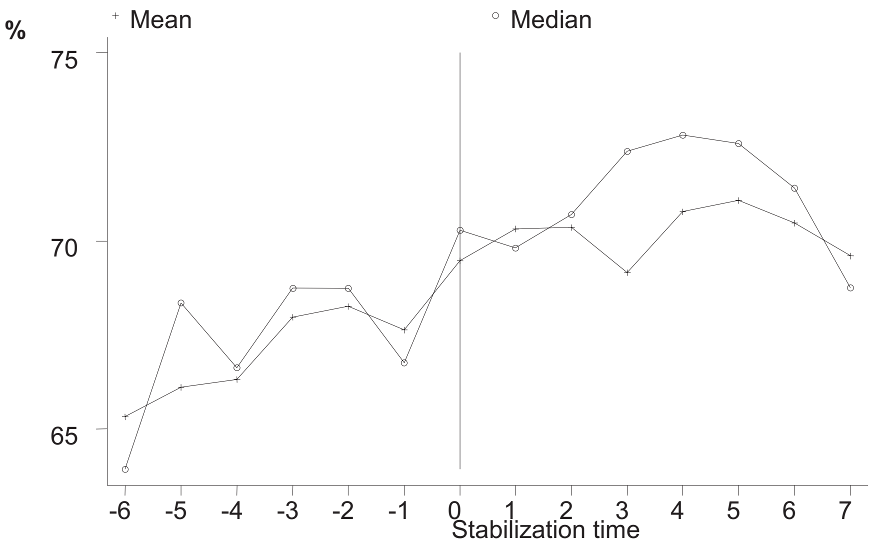

Figure 1.8: The consumption-to-GDP ratio

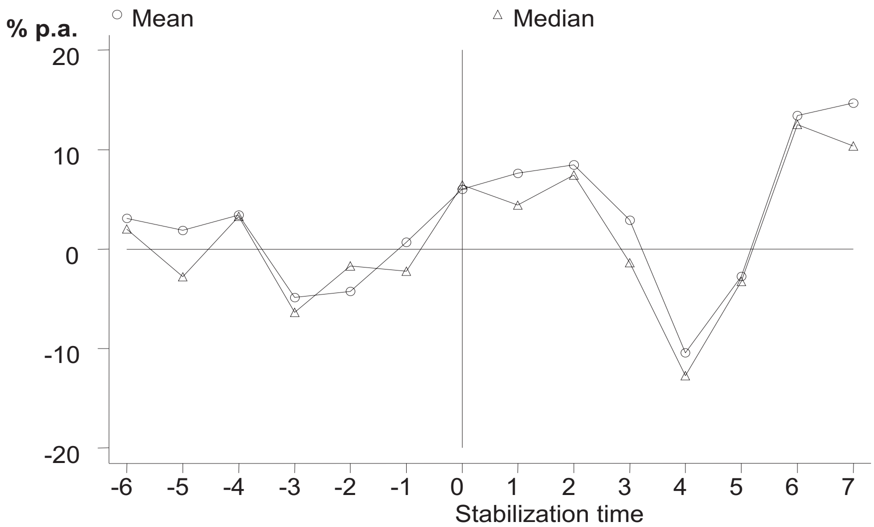

Figure 1.9: Investment growth during stabilization

Even though not based on systematic empirical evidence, it has been argued that ex ante non-credible stabilizations tend to be most expansionary. As an informal test of this allegation, the rate of consumption growth is correlated with the spread, that is, the differential between domestic and US nominal interest rates. Assuming simple interest rate parity to hold, the spread should capture agents' devaluation rate expectations and thus the peg's credibility.[32] This yields positive correlation coefficients for seven out of 12 stabilizations, namely, those in Mexico (0.73), Argentina (1991: 0.64), Israel (0.44), Brazil (1985: 0.34; 1994: 0.13), Uruguay (1991: 0.30), and Chile (0.14), whereas the average correlation merely amounts to 0.08.[33] This suggests that devaluation rate expectations might be particularly relevant for the consumption boom during stabilizations in chronic inflation countries. However, the evidence is too fragile as to include it in the list of stylized facts, particularly as the small sample size and informal derivation of devaluation rate expectations preclude conclusions beyond conjecturing.

Gross capital formation (figure 1.9, 'investment' henceforth) appears to follow an expansion-recession cycle similar to consumption.[34]

The investment-to-GDP ratio (figure 1.10), however, starts rising only in

[32] For a detailed discussion of possibilities to quantify devaluation rate expectations, the reader is referred to Chapter 3.

[33] Due to lacking data on nominal interest rates, the stabilization in Egypt is excluded.

[34] Due to a lack of data, mean and medians exclude the stabilizations in Egypt and Uruguay (1978).

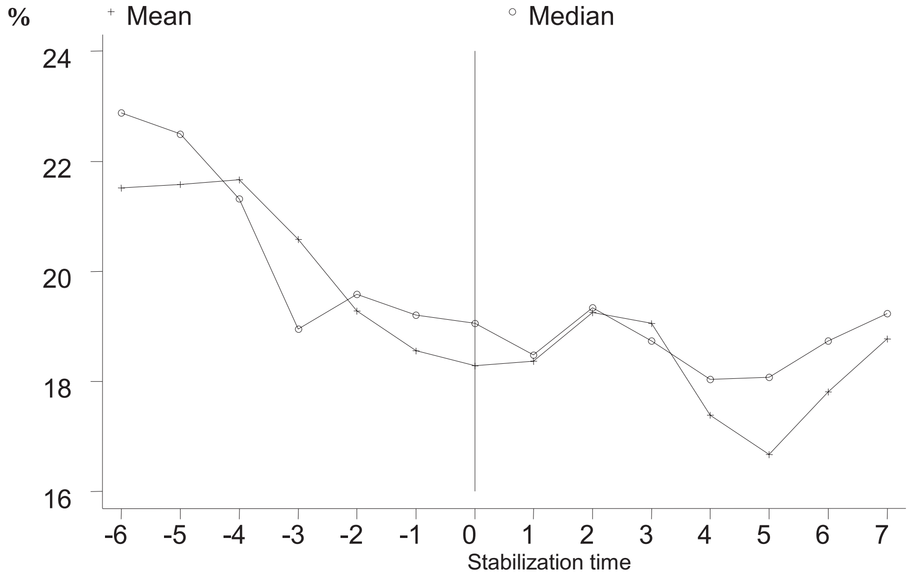

Figure 1.10: The investment-to-GDP ratio

the second year after the official announcement of ERBS. Moreover, the secular fall in the investment-to-GDP-ratio seems to be only temporarily reversed. This is confirmed when comparing the rates of change in the consumption-to-GDP and the investment-to-GDP ratios: During the stabilization-time interval from -3 to 4, the former increases in years 0 and 2 to 4 (by 5.26, 1.28, 2.38 and 0.60 percent, respectively), whereas the investment-to-GDP ratio rises only in periods -2 and 2 (by 3.35 and 4.60 percent, respectively). To assess the robustness of the investment expansion, investment dynamics during the individual stabilization episodes are presented in figure 1.11. This exercise illustrates the pitfalls of averaging over stabilization episodes: 'Eyeball econometrics' suggest that only six of 11 episodes exhibit a stabilization-associated rise in investment,[35] whereas the remaining stabilizations are either accompanied by a contraction of investment or investment fluctuations which do not appear to be systematically linked to the devaluation rate.

Figure 1.12 presents the ratio of the change in inventories to GDP.[36] Its dynamics are similar to those of the investment-to-GDP ratio.

Data on capacity utilization before and during episodes of ERBS is scarce.

[35] Namely, the Argentinean (1985 and 1991), Chilean, Israeli, Peruvian and Uruguayan (1991) stabilizations.

[36] This average is based on stabilizations in Brazil (1994), Chile, Iceland, Israel, Mexico and Uruguay (1991). Data on inventories is not available for the remaining episodes.

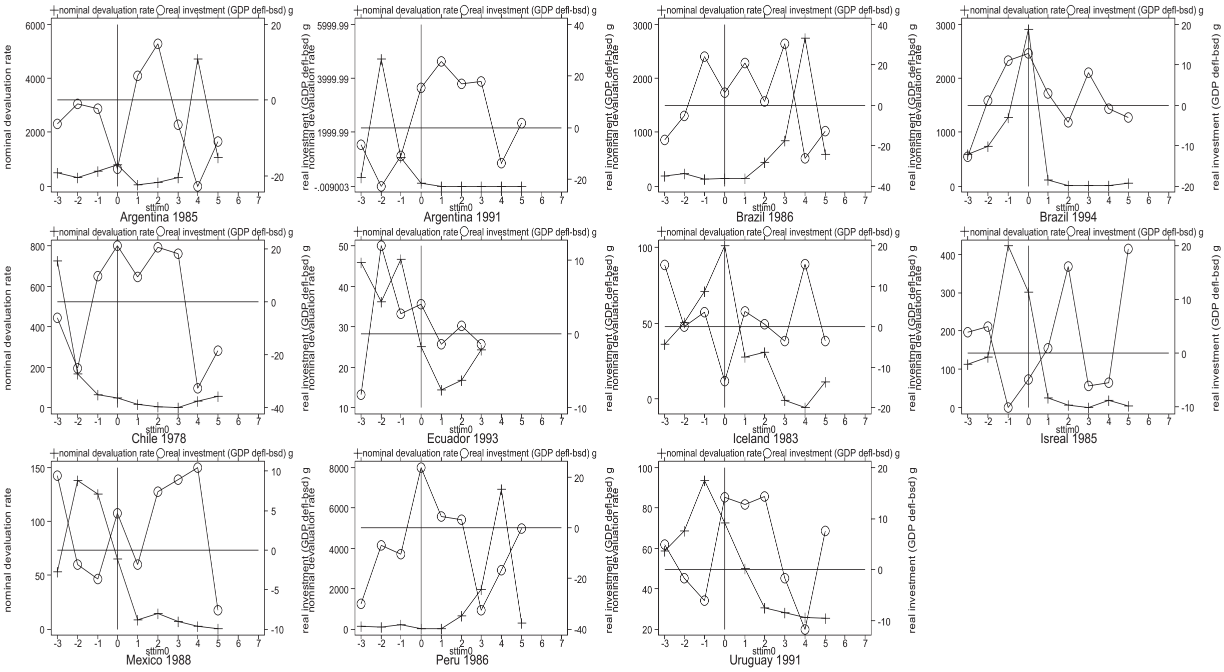

Figure 1.11: Investment growth during individual stabilizations

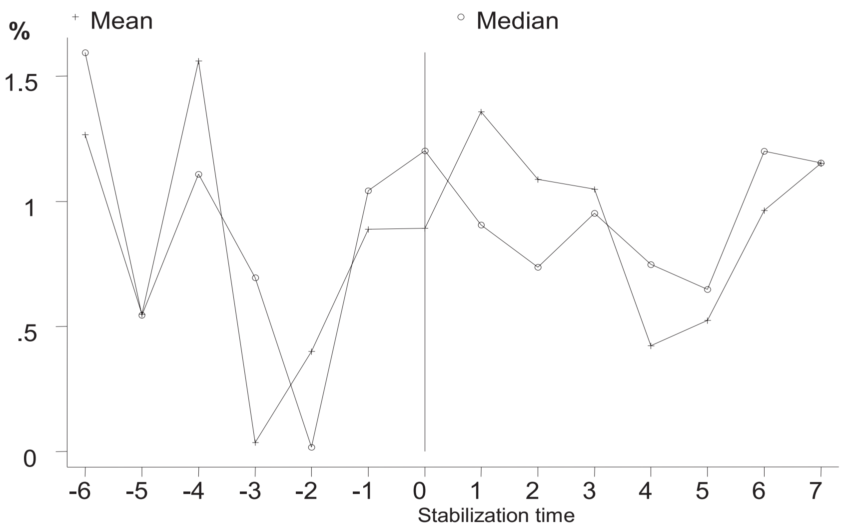

Figure 1.12: The ratio of inventories' increase or decrease (–) to GDP

Figure 1.13: Capacity utilization in Brazil

Figure 1.13 presents quarterly average capacity utilization rates in the Brazilian manufacturing industry. The vertical line indicates the beginning of the most recent exchange rate peg, the Real stabilization which was associated with increased capacity utilization – its maximum value of 86 percent is reached three quarters after stabilization-time year zero.

Figure 1.14 presents the unemployment rate during stabilization. Both mean and median unemployment rise in the year of stabilization and decrease by considerable amounts in the ensuing year.

While the unemployment dynamics after stabilization are roughly reverse to those of GDP growth, this is not the case before and in the year of stabilization. However, the aggregates should be interpreted with caution, as some periods are based on few observations – due to lacking data, the averages do not include the Chilean and the first Uruguayan stabilizations. For another nine episodes, data was not available for the entire period under consideration.[37] Figure 1.15 reports the unemployment rate and the devaluation rate for the individual stabilizations. Most episodes are characterized by a temporary fall in unemployment, followed by a persistent increase. This pattern seems to occur regardless of the program's duration, that is, it is also present during programs where the devaluation rate remains at moderate levels throughout

[37]For the following episodes, data is limited to the years specified: Argentina 1984-99; Brazil 1984-95; Ecuador 1987-98; Egypt 1989-95; Mexico 1988, 91, 93, 95; Peru 1986-93; Uruguay 1986-98; Iceland 1985-90; Israel 1985-92.

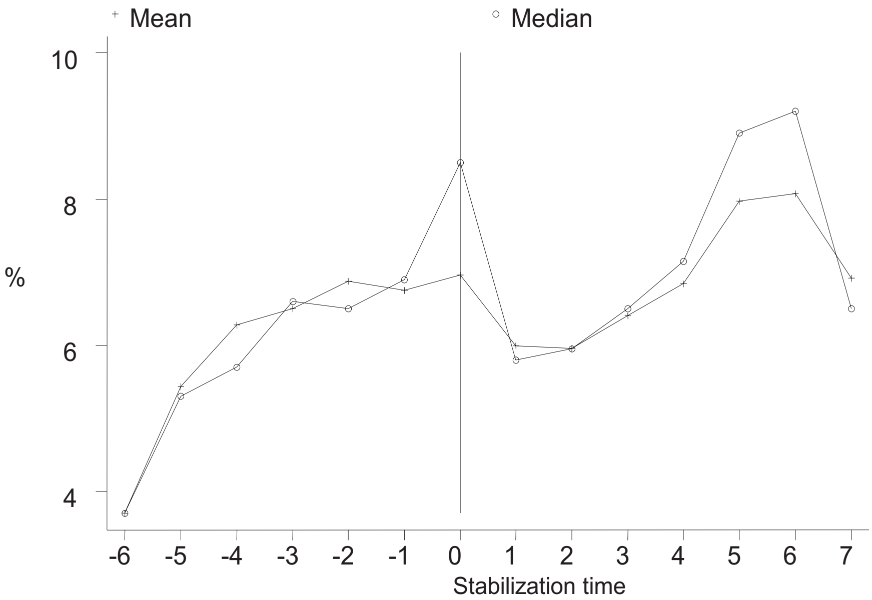

Figure 1.14: The unemployment rate, % p.a.

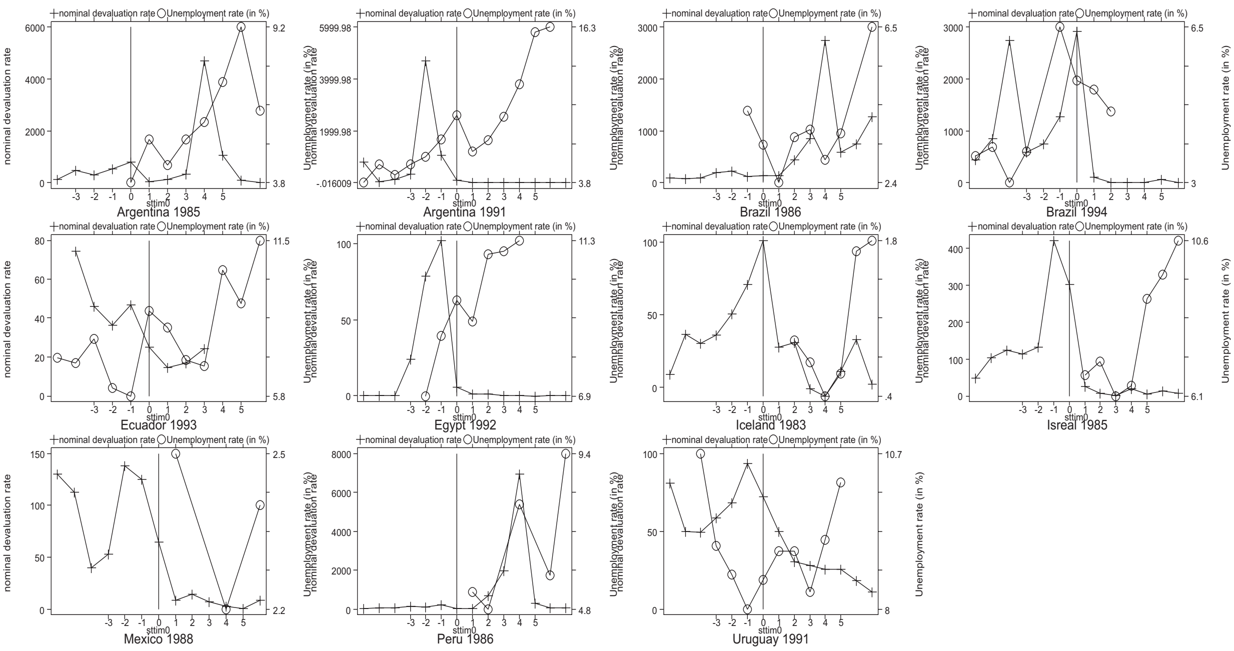

Figure 1.15: Unemployment during the individual stabilizations

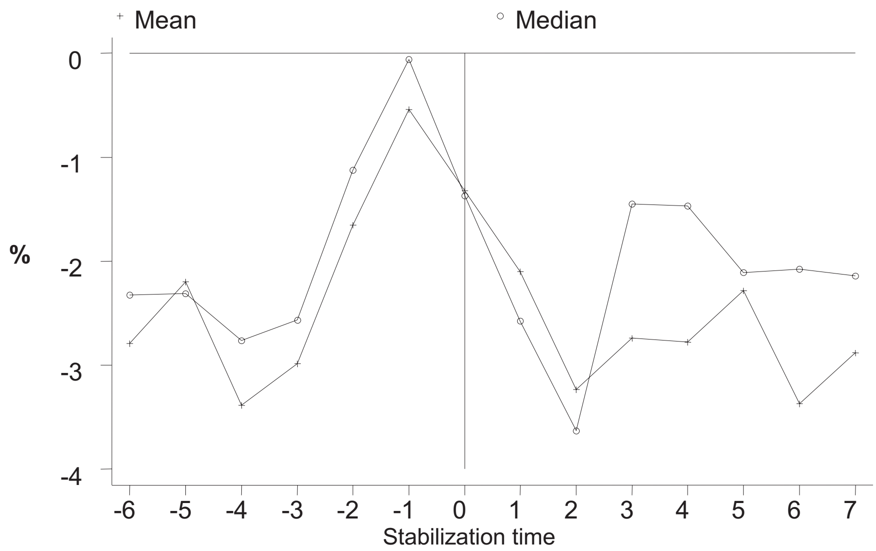

Figure 1.16: The current account balance-to-GDP ratio

the seven post-stabilization years considered here: Unemployment dynamics during the very short-lived Argentinean stabilization during the eighties, for example, look very similar to those during the relatively extended currency board arrangement which was implemented in 1991. Only during three episodes unemployment decreases by more than one percentage point: During the recent stabilizations in Argentina (1991), Brazil (1994), and Ecuador, the unemployment rate fell by an absolute amount of 2.9, 1.2, and 1.2 percentage points (in periods 1, 0, and 2), respectively. It should be noted, however, that the unemployment dynamics could very well reflect measures accompanying ERBS, which often include layoffs in the public sector, and not (solely) the effect of the devaluation rate stabilization.

Figure 1.16 graphs the current account balance-to-GDP ratio. Starting out with a balanced (median) current account in the year preceding ERBS, a deficit of 3.63 percent of GDP is reached two years later. The economies' current account deficits are financed with capital imports: The financial account balance, which includes direct investment, classified as investment where the investor "seeks a significant voice in the management of an enterprise" (IMF 1993:80), portfolio investment, other investment (e.g. trade credits), and reserve assets, moves inversely to the current account balance (see figure 1.18).[38]

[38]The financial account is defined as the capital account less receipts or payments of capital transfers, and the acquisition or disposal of non-produced financial assets (see IMF 1993:77f).

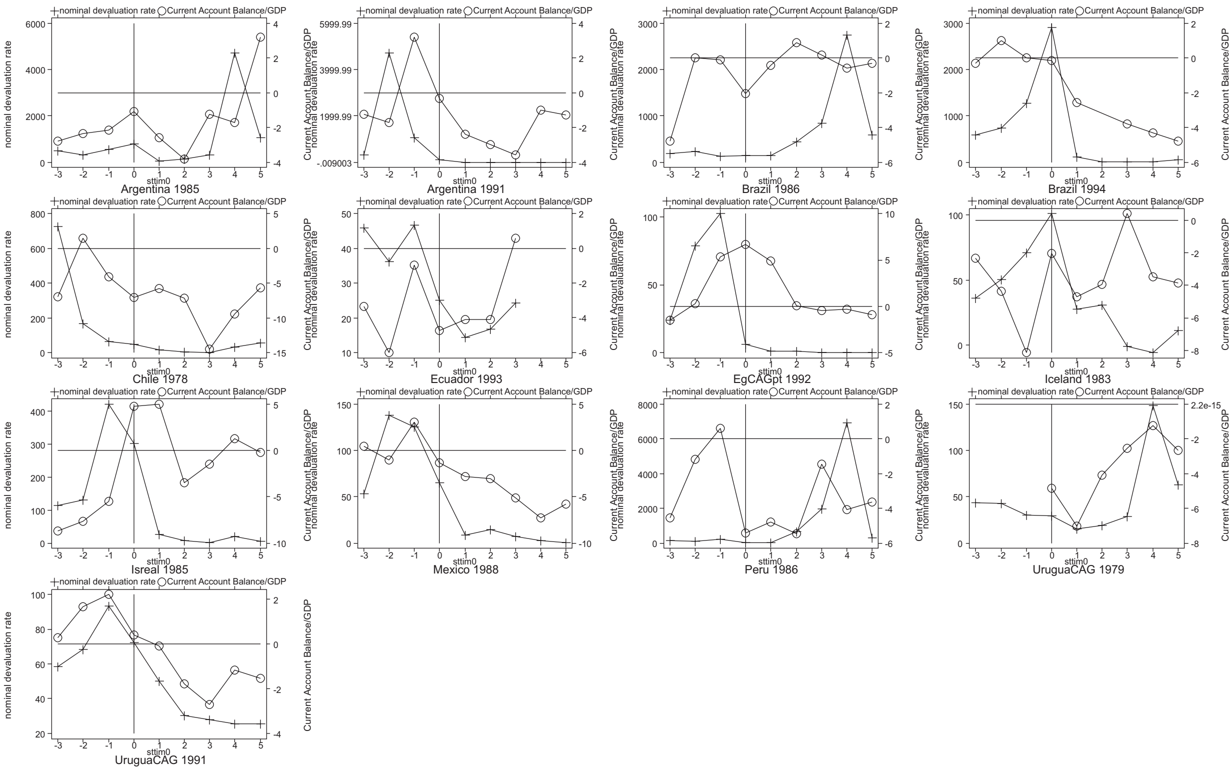

Figure 1.17: The current-account-to-GDP ratio for individual stabilizations

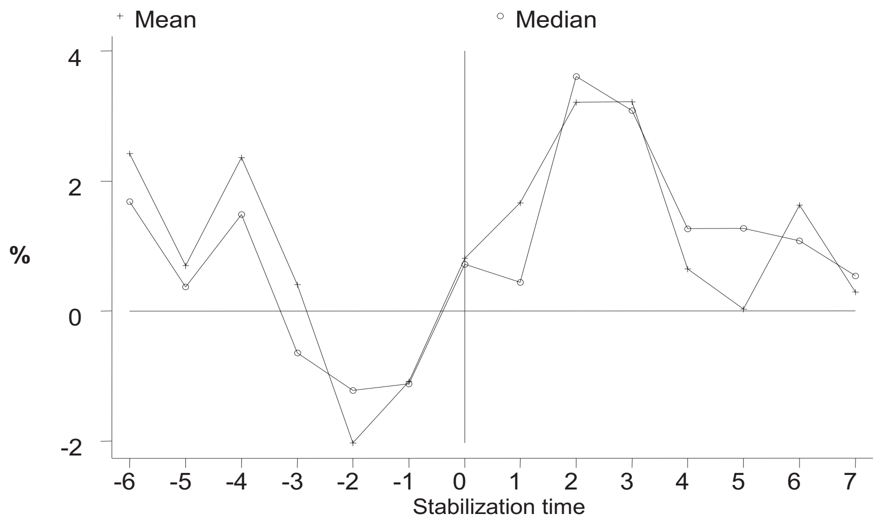

Figure 1.18: The financial account-to-GDP ratio

The maximum (median) financial account balance of 3.61 percent of GDP is reached two years after the official announcement of stabilization.

Figures 1.17 and 1.19 confirm that the current account deterioration and capital inflows are characteristic of each of the individual stabilization episodes under consideration.

To assess the importance of rather short-term and highly liquid capital flows, figure 1.20 presents the ratio of net portfolio investment assets to GDP. Portfolio investment includes investment in equity and debt securities other than direct investment (IMF 1993:81). The graph shows that stabilization is associated with a pronounced increase in short-term capital inflows to the economy. Note, however, that the aggregates do not include the stabilizations in Chile, Ecuador, Iceland, Uruguay and Peru. Furthermore, only Israeli and Mexican data was available for the entire period under consideration.[39] As a robustness check, the portfolio investment net foreign assets-to-GDP ratio during these two stabilizations is presented in figure 1.21. The reversal of capital inflows to Mexico between stabilization-time years 6 (that is, the year 1993) and 7 (1994) captures the Mexican currency crisis in December 1994. Similarly, the pronounced reversal of capital inflows four years after the start of the Israeli peg occurred when the devaluation rate rose from 0.2 to 19 percent between 1988 and 1989. However, the peg was not officially

[39]For the stabilizations in Argentina and Egypt, the data is limited to the years 1990 to 2000 and 1998 to 1999, respectively.

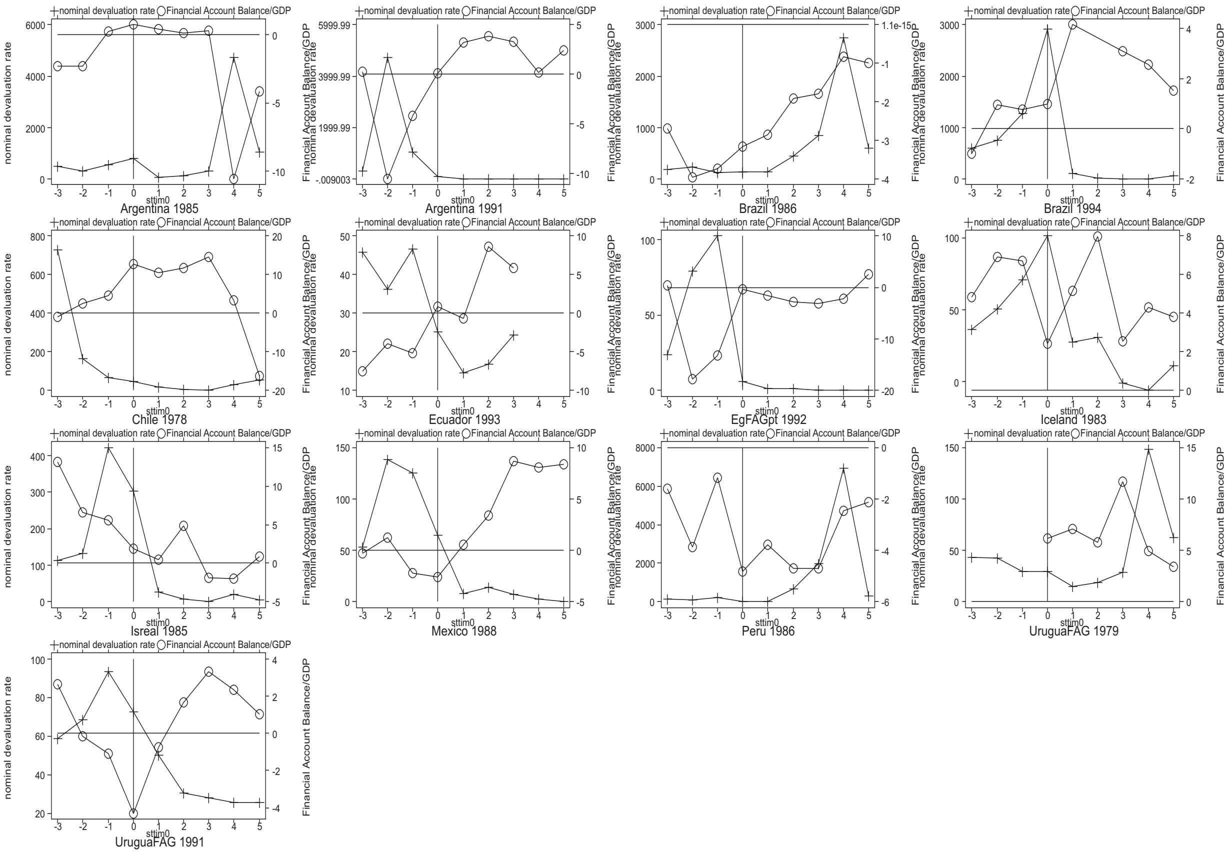

Figure 1.19: The financial account-to-GDP ratio for individual stabilizations

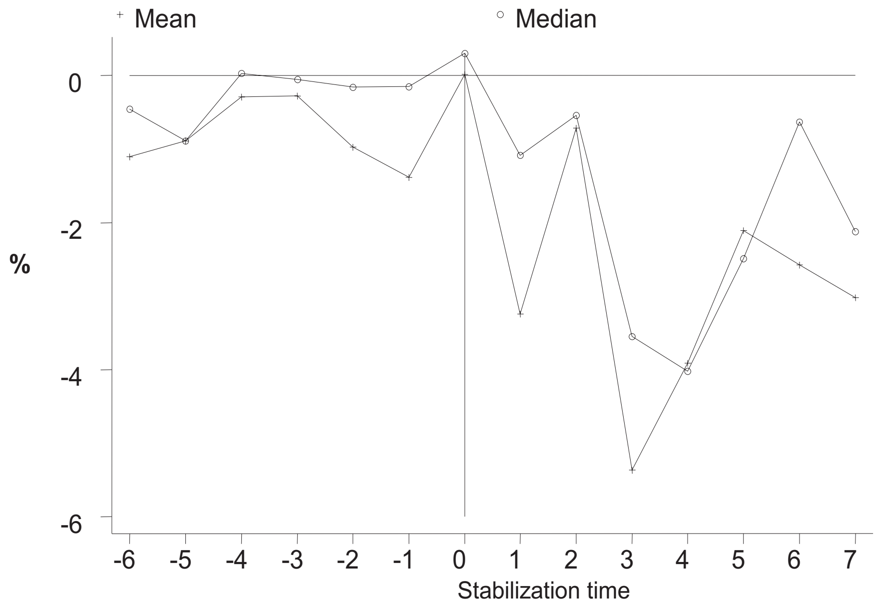

Figure 1.20: The ratio of net portfolio investment assets to GDP

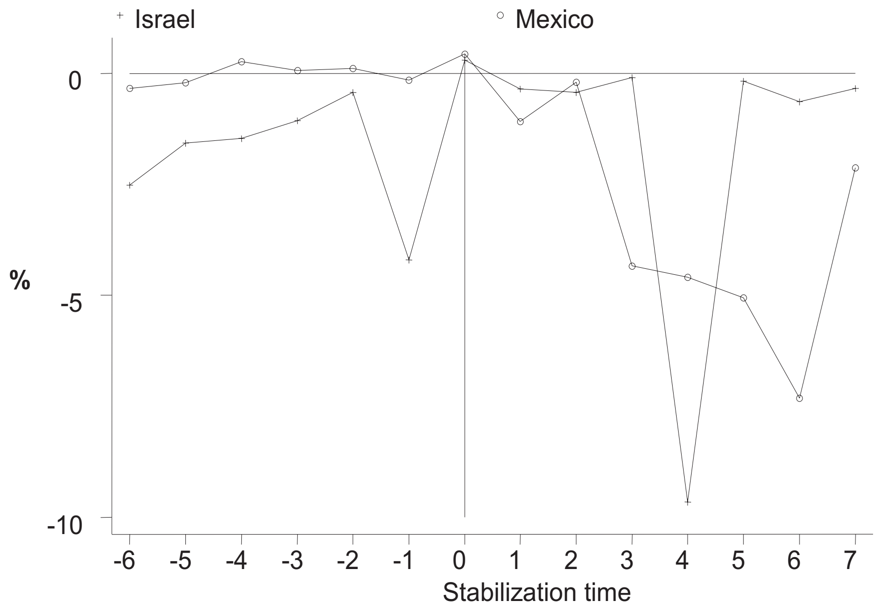

Figure 1.21: The ratio of net portfolio investment assets to GDP in Mexico and Israel

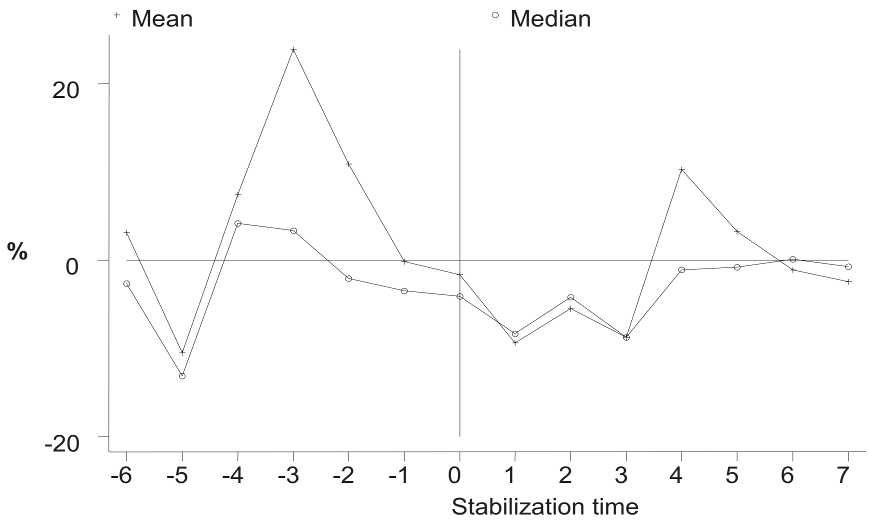

Figure 1.22: The real depreciation (+)/ appreciation (-) rate during stabilization (in % p.a.)

abandoned and the devaluation rate was reduced to 5 percent in 1990. In sum, the data on portfolio investment reveals that stabilization is associated with a pronounced increase in capital imports, which is reversed only three to six years after the implementation of stabilization, coinciding with the rise in mean and median devaluation rates.

Figure 1.22 presents the percentage change in the real exchange rate. The real exchange rate is calculated as the ratio of US to domestic consumer prices, both expressed in domestic currency.[40] Given this definition, a real appreciation is equivalent to a negative growth rate. Figure 1.22 gives account of a pronounced real exchange rate appreciation which starts at the same time as the devaluation rate reduction. It is not halted until four to six years after stabilization, when the majority of pegs have been abandoned.

Next, stabilization-time profiles of real credit and real money growth are presented. The *International Financial Statistics* report overall credit, credit to the private sector and banks' credit to the private sector. As these three measures turned out to follow very similar dynamics, only credit to the private sector is reported here.

Figure 1.23 gives evidence of a credit contraction in the year of stabilization, followed by positive growth rates in the ensuing four years. This suggests

[40]The real exchange rate is based on consumer prices since these are readily available. For comparisons of international competitiveness, a wage-based real exchange rate measure would be preferable.

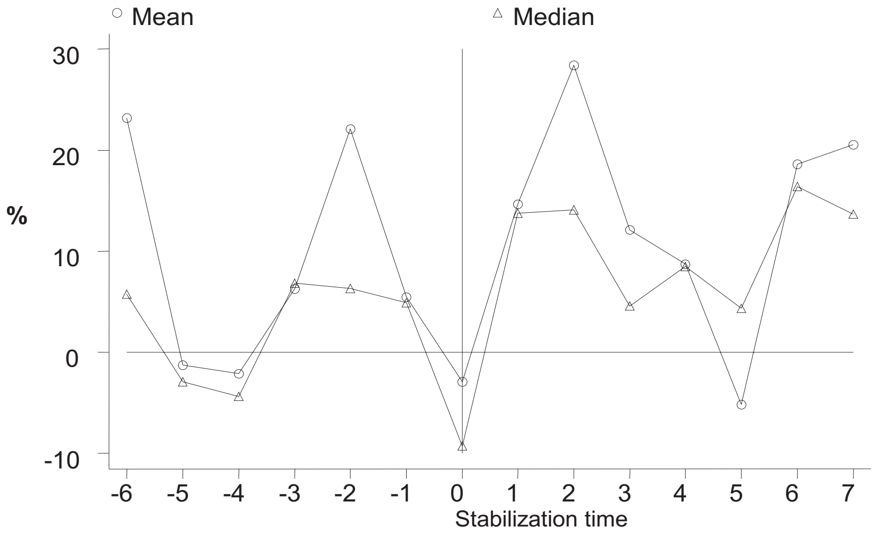

Figure 1.23: Real credit growth during stabilization (in % p.a.)

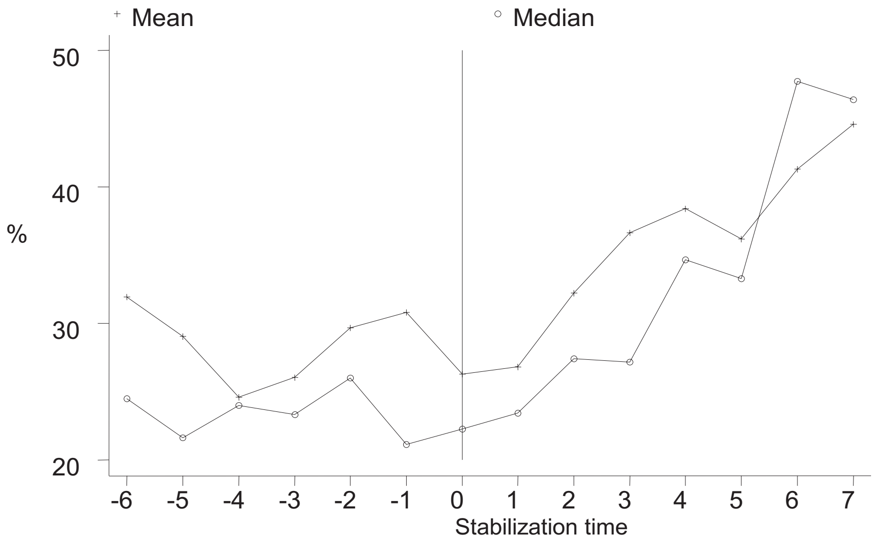

Figure 1.24: The credit-to-GDP ratio

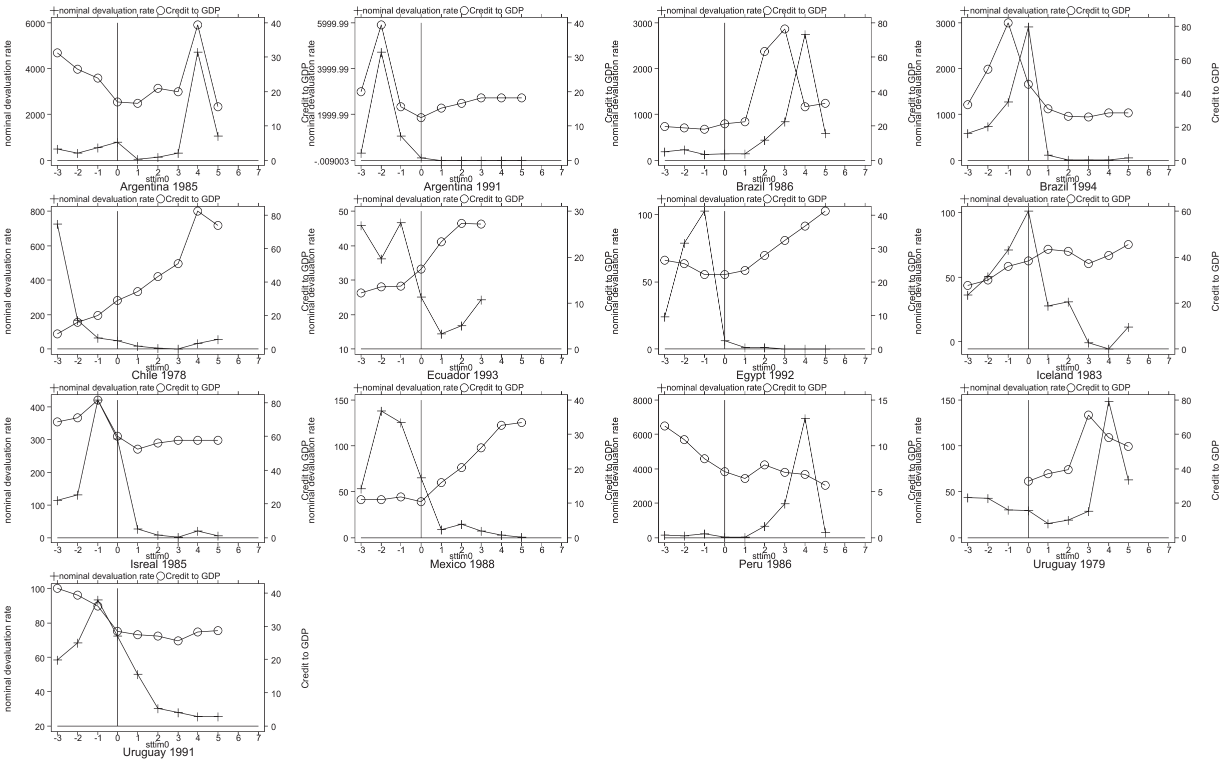

Figure 1.25: The credit-to-GDP ratio during the individual stabilizations

that credit follows consumption and GDP with a lag. This is confirmed by the correlations of consumption and credit growth: The correlation coefficient of 1-year lagged consumption and credit is 0.38, whereas the contemporaneous correlation of median consumption and credit growth amounts to 0.0005, and the correlation coefficient of consumption and 1-year lagged credit to -0.26. This suggests that the observed rise in consumption and GDP growth cannot be entirely attributed to a relaxation of credit constraints. However, five of the 13 stabilization episodes under consideration – namely, the ERBS in Ecuador, Chile, Iceland, Israel and Mexico – are characterized by positive contemporaneous correlations of credit to the private sector and consumption, with correlation coefficients of 0.14, 0.19, 0.46, 0.35 and 0.64, respectively. The relatively high correlations found for Iceland, Israel and Mexico suggest that the linkage between credit and consumption increases in financial markets' sophistication and size.

The contemporaneous correlation of median real credit growth and the median devaluation rate is negative with a correlation coefficient of -0.43; for the individual stabilizations, the correlation is positive only during the episodes in Argentina (1985, 1991) and Iceland.[41] Figure 1.25 reports the credit-to-GDP ratio and the devaluation rate for each stabilization. While some episodes, as for example the ERBS in Chile, Ecuador and Mexico, are clearly associated with an increase in credit relative to GDP, this does not appear to be a *general* regularity.

The path of median real reserve money growth is similar to that of the devaluation rate (see figures 1.26 and 1.27). Both variables start contracting two years before the official announcement of stabilization. The jump in reserve money growth in year 3 reflects that many programs have been abandoned by that date. Figure 1.28 gives evidence of the decline in the reserve money-to-GDP ratio during the early stages of stabilization.

Lastly, the government budget is analyzed: Figure 1.29 presents the government surplus (or deficit)-to-GDP ratio, where deficits carry a negative sign. ERBS is accompanied by fiscal consolidation; the 'median government budget' is balanced in stabilization-time year 1. However, the data needs to be interpreted with caution, as many countries underreport the total deficit, for example by not including deficits of the provinces.

Government expenditure as a percentage of GDP increases in the year of stabilization, and decreases thereafter. However, figure 1.30 does not provide conclusive evidence if a venue of sustained consolidation is followed or not:

[41] With correlation coefficients of 0.50, 0.44 and 0.25, respectively. The remaining correlation coefficients amount to -0.17 (Brazil 1986), -0.32 (Brazil 1994), -0.20 (Chile), -0.83 (Ecuador),-0.62 (Egypt), -0.16 (Israel), -0.75 (Mexico), -0.28 (Peru), -0.62 (Uruguay 1978), and -0.53 (Uruguay 1991).

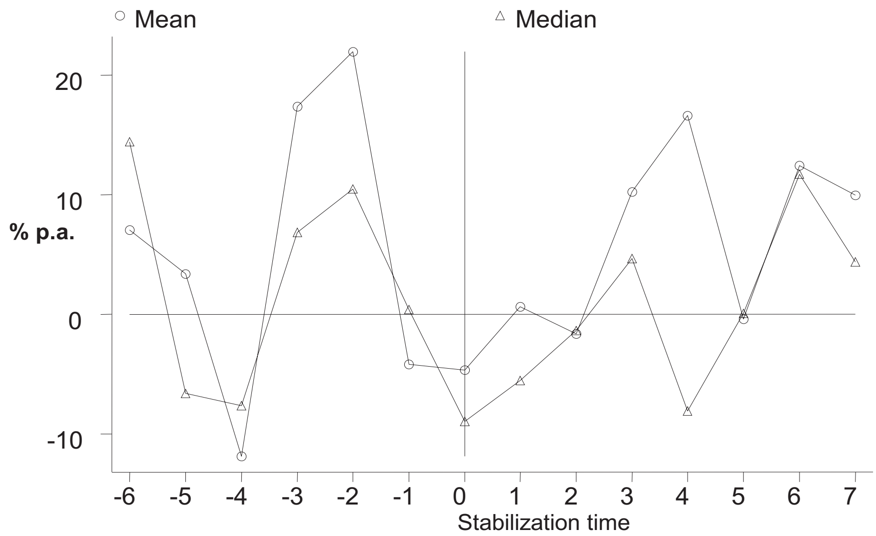

Figure 1.26: Real money growth during stabilization

The development of the mean suggests that the former could be true; the median contradicts this impression.

Government revenue (which excludes grants) to GDP rises in the year of stabilization and decreases thereafter, see figure 1.31. The increase in revenues could thus very well be due to the (temporary) stabilization-induced increase in the tax base, namely, consumption and GDP, and not due to structural consolidation. The slight improvement of the government's finances, as reflected in the decreasing deficit-to-GDP ratio seems to be brought about by a slight reduction of government spending, rather than increasing government revenues. Note that both the government deficit and government spending rise notably three years after the implementation of stabilization, reflecting that many programs are abandoned at that date.

This section empirically assessed the real effects of ERBS in high inflation economies. The analysis confirms important stylized facts of ERBS pointed out by the literature, namely, the initial increases in consumption and GDP, the real appreciation and the current account deterioration. Moreover, consumption and output are found to follow a boom-*slowdown* cycle, where 'slowdown' means reduced or zero growth if the ERBS is still in effect, and negative growth for failed ERBS. In contrast to the case-studies literature, my analysis reveals that stabilization is accompanied by a moderate expansion of investment. However, the heterogeneity of investment behavior across stabilizations precludes defining an additional stylized fact. This applies in similar

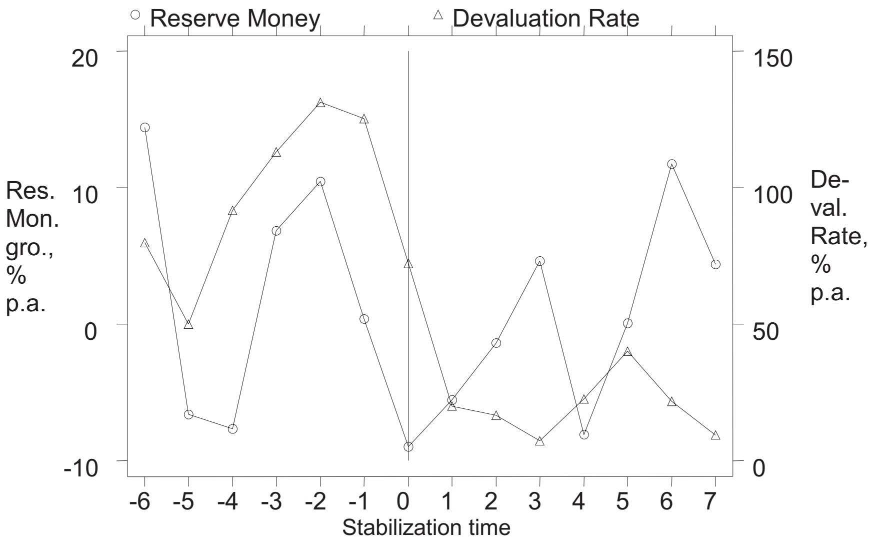

Figure 1.27: Real money growth and the devaluation rate

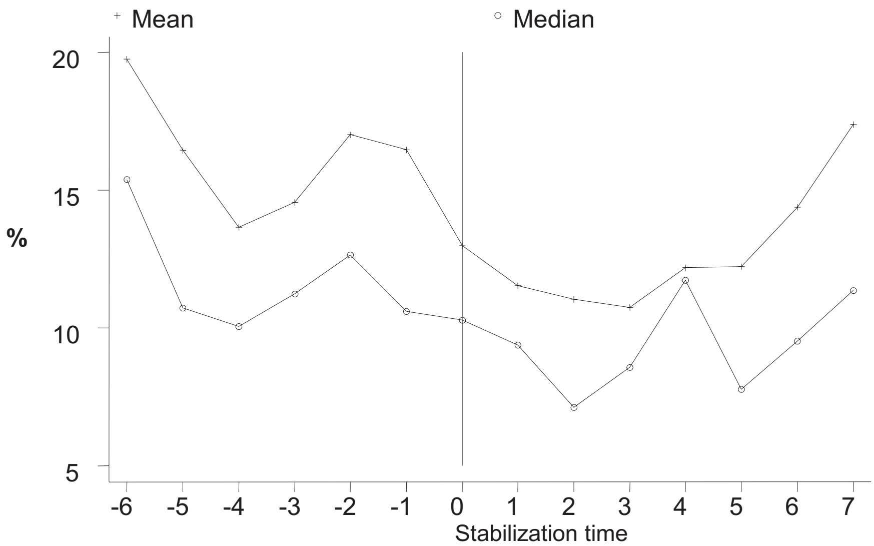

Figure 1.28: The money-to-GDP ratio

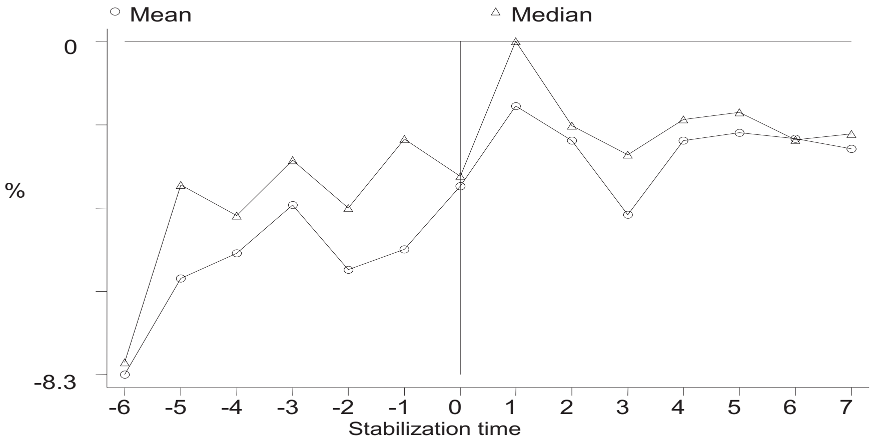

Figure 1.29: The government deficit (-)-to-GDP ratio (in %)

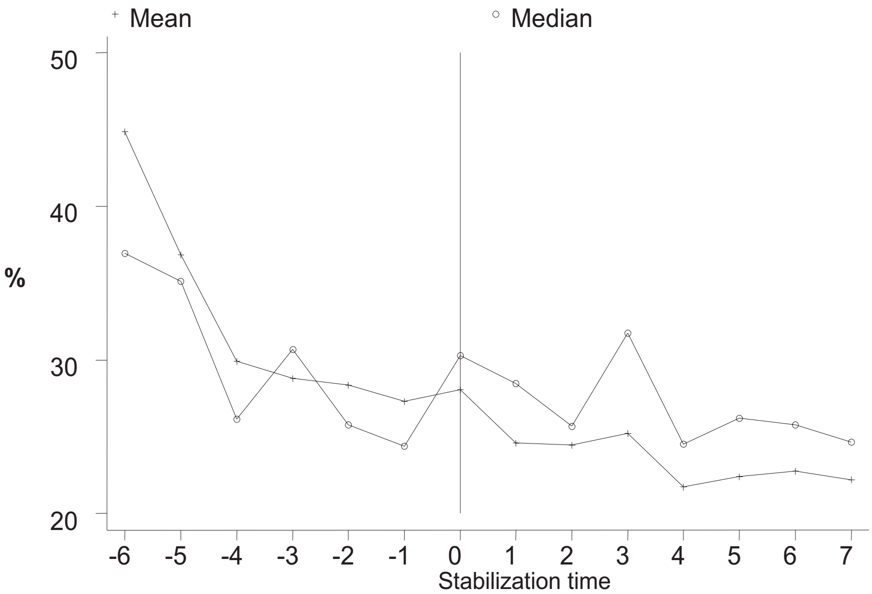

Figure 1.30: The government expenditure-to-GDP ratio (in %)

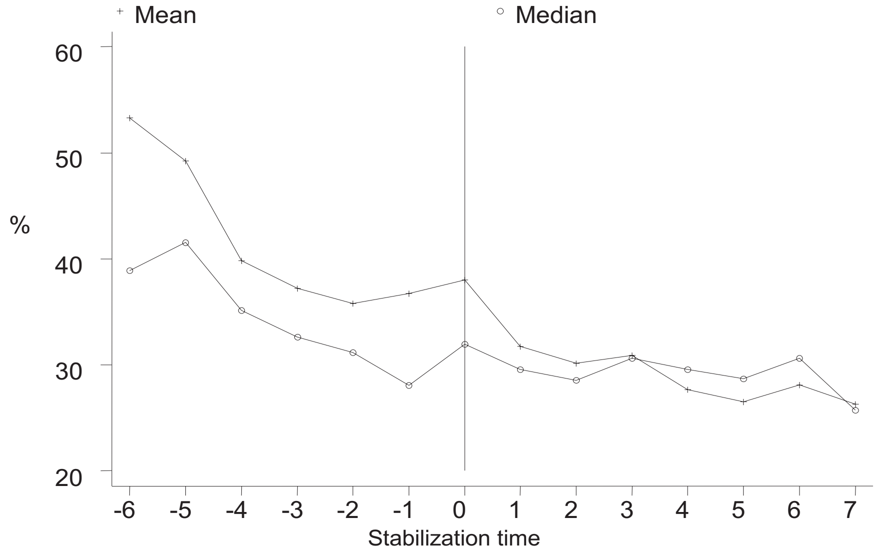

Figure 1.31: The government revenue-to-GDP ratio

manner to the stabilization-time pattern of inventories. Unemployment – a variable neglected by most previous empirical studies – falls during the first year of stabilization, but then increases to exceed its pre-stabilization level. An expansion of credit to the private sector appears to constitute an additional stylized fact. However, in contrast to what is commonly claimed,[42] the rise in credit occurs *after* the increases in output and consumption. Capital inflows, in particular portfolio investments, rise in the year the stabilization is officially announced, followed by a sharp reversal three to six years later. If a fiscal consolidation is achieved, this seems to be due to increasing revenues, rather than reduced spending. An additional empirical regularity is the programs' collapse: Almost half the episodes analyzed in the first chapter of this dissertation ended in a currency crisis within five years, 70 percent within ten years after their implementation.

Although these results are certainly suggestive, the limits of this – and most other – empirical analyses of high inflation economies should be recognized: Despite considering a greater number of stabilizations than is typically the case in the literature, the sample is still (statistically) small, and a sample selection bias cannot be ruled out completely. Moreover, the data is likely to vary greatly in quality, with data for the lower income economies, and the 'early' stabilizations of the eighties being particularly questionable.

[42]For example by models which explain the consumption boom with a simultaneous rise in credit. These will be reviewed in section 1.5.

Stabilization-time dynamics have been presented in an informal manner without controlling for shocks other than stabilization, or de-trending the data. This research strategy was chosen since I consider an application of sophisticated econometric techniques to be precluded by the scarcity of reliable data on high inflation economies. It might even be counterproductive, as its results would suggest a numerical exactness which cannot be sensibly assumed given the quality of the data.

1.4 Exchange Rate versus Money-Based Stabilization - Are the Real Effects Different?

Section 1.3.2 gave account of the widespread recurrence to ERBS as a tool for stabilizing high inflation. A policy alternative is money-based stabilization, that is, direct targeting of the nominal money supply. In theory, ERBS and MBS can be shown to be quite similar. In fact, if inflation stabilization does not affect money demand, credible ERBS and MBS are identical (Fischer, 1986). If, however, lower inflation is associated with an increase in money demand, a strict money target generates a more severe liquidity crunch than an exchange rate peg: During ERBS, the central bank can – and must, in order to avoid an appreciation of the domestic currency – increase money supply as long as this is matched with demand for home currency in the foreign exchange market. During MBS, in contrast, the central bank cannot respond to the post-stabilization increase in money demand by increasing money supply, as this would put into jeopardy the money target (Sachs 1995:182). Given this constraint, one would expect MBS to be less expansionary than ERBS. This is empirically confirmed by Kiguel and Liviatan (1992), and Calvo and Végh (1994a) , who, based on samples of six and five MBS, respectively, find that these are typically accompanied by an initial recession. Other stabilization-time dynamics are reported as similar to those during ERBS: The inflation rate is slow to decrease, and the real exchange rate appreciates by similar amounts. Despite the small sample size, these findings have been generalized to the wisdom that choosing between MBS and ERBS is equivalent to choosing between 'recession now versus recession later' (Calvo and Végh, 1994a:35) – a claim which has been contradicted by studies based on larger samples of stabilizations: Easterly (1996) and Hamann (2001) report stabilization of high inflation to be expansionary regardless of which nominal anchor is used; in fact, Easterly (1996:91) finds no statistical difference between year-by-year mean growth during ERBS and non-ERBS.

In view of this controversy, the main objective of this section is an assessment of output movements during MBS, with the aim of providing further evidence if these are indeed accompanied by an output expansion. A comprehensive comparison of money versus exchange rate targeting as a tool of inflation stabilization is beyond the scope of this section; the reader is referred to a contribution by Uribe (1999), who compares the programs' welfare and credibility effects, and to Tornell and Velasco (1995, 1998) for their effects on fiscal discipline. Long-run considerations related to the choice of a money or exchange rate anchor, in particular developing countries' optimal exchange rate arrangements, have been recently discussed by Mussa et al. (2000) and Larrain and Velasco (2001).

The sample under consideration here consists of nine episodes of MBS, namely, those in Bolivia (1985), Costa Rica (1982), Dominican Republic (1990), Ghana (1982), Kenya (1991), Nigeria (1987), Peru (1991), Uganda (1981), and Uruguay (1990). These episodes are those MBS considered by Easterly (1996) which are actually associated with a reduction in real money growth and for which data is publicly available.[43]

Given the focus on the short-run real effects of MBS, only four post-stabilization years of data are considered. The data is compacted by averaging over the two years preceding the stabilization ('pre-stabilization period' hereafter), the first two post- stabilization years (hereafter 'post-stabilization short run'), and the third and forth year after stabilization (hereafter 'post-stabilization long run'). 'Stabilization' is defined to occur in the year where base money growth is first reduced (denoted as 'year of stabilization'). It should be reiterated that much of the data, particularly on the African episodes, is contaminated by measurement errors. Furthermore, a sample selection bias cannot be ruled out: As pointed out in section 1.3.1, Easterly's sample − which is the basis of mine − considers only stabilizations where the inflation rate is actually reduced and remains at the lower level for at least two years. In generally, MBS which do not succeed in reducing the inflation rate tend to go by unnoticed. Therefore, the stylized facts of MBS are rather the stylized facts of *effective* MBS. Furthermore, MBS have been implemented more frequently in African than in Latin American economies, which have been prone to implement ERBS. My sample of MBS includes four African and four Latin American and Caribbean countries, in contrast to the sample of ERBS, which contains no African and 10 Latin American countries. Thus, alleged differences between MBS and ERBS might also reflect

[43]Four of Easterly's MBS, namely, the stabilizations in Ghana (1983), Guinea-Bissau (1992), Iceland (1974) and Jamaica (1991), did not involve a significant stabilization of money growth (or inflation rates).

differences between stabilization outcomes in Africa and in Latin America.[44] This (potential) bias is also present in Hamann's analysis, whose sample of 13 ERBS consists of 11 stabilizations in Latin America and none in Africa, whereas the MBS include 17 African stabilizations.

An additional bias might arise from the fact that the choice of money or the exchange rate as a nominal anchor is not exogenous: The implementation of an exchange rate peg requires the central bank to hold a certain amount of foreign currency reserves, which suggests that a central bank which implements an ERBS might be more powerful than one which implements a MBS. On the other hand, the highly visible nominal exchange rate anchor is often used in chronic countries in order to break with inflation inertia, that is, in countries where the central bank's credibility is typically low. This is also reflected in the fact that Latin American policymakers have favored the exchange rate over money growth as a nominal anchor, which contrasts with stabilizations in Africa, where chronic inflation is absent and MBS predominate. My data indicates that the choice of MBS versus ERBS does not hinge on the economic situation prior to stabilization: GDP contracts on average by -0.8 and -1.4 percent prior to the decline in the devaluation rate achieved through ERBS and MBS, respectively. However, as pointed out in the previous section, inflation and devaluation rates typically start to decrease (and GDP to rise) before the official start of the exchange rate peg. Since this is not the case in MBS, analyzing GDP movements solely around the official starting dates might erroneously suggest that ERBS are implemented under more favorable economic conditions than MBS.

In view of these caveats, the dynamics during ERBS and MBS are not compared directly – this would suggest a numeric precision which cannot be sensibly assumed given the sample and data under consideration. Instead, *tendencies* during MBS will be pointed out and compared to those during ERBS.

The first row of table 1.3 reports the percentage change in the reserve money-to-GDP ratio before and during stabilization. The data shows that MBS achieve a drastic decline in money growth, which is associated with a considerable inflation rate reduction. In contrast to what was found for ERBS, stabilization is associated with a decline in credit to the private sector, which confirms the hypothesis of a more pronounced liquidity crunch during MBS.

Is money-based stabilization contractionary? On the basis of the above GDP data, the answer is negative: Average GDP growth during MBS exceeds its pre-stabilization level. The expansion occurs slightly later than during

[44] Comparing ERBS and MBS in Africa and Latin America separately is not feasible here, as this would drastically reduce the sample size.

Period	Pre-stabilization	Year of stabilization	Post-stabilization short run	Post-stabilization long run
Reserve money-to-GDP ratio (% change p.a.)	21.51	-30.07	-3.12	2.57
Credit to priv. sector-to-GDP ratio (% change p.a.)	66.63	-14.48	1.72	7.55
Inflation rate	809.98	1412.96	49.73	30.31
Devaluation rate	615.67	1716.90	73.14	34.57
GDP growth	-1.4	0.9	4.01	3.57
Consumption growth	-1.77	-5.6	0.78	7.92
Consumption growth excluding Nigeria and Kenya	-5.52	-5.70	5.75	3.38
Investment growth	-1.93	-12.93	6.22	0.59
Government deficit-to-GDP ratio	-15.43	-7.16	-6.60	-4.52

Notes: 'Pre-stabilization' denotes the average of the 2 years preceding stabilization, 'post-stabilization short run' the average of the 2 years after stabilization, and 'post-stabilization long run' the average of the third and fourth year after stabilization.
Ad reserve money and credit: Due to missing data, the average does not include observations for Uganda in the pre-stabilization period.
Ad consumption growth: Due to missing data, the average does not include observations for Bolivia in the pre-stabilization period, Uganda and Peru.
Ad investment growth: Due to missing data, the average does not include observations for Bolivia in the pre-stabilization period, Ghana, Uganda and Peru.
Ad government deficit-to-GDP ratio: Due to missing data, the average does not include observations for Uganda in the pre-stabilization period and Bolivia.

Table 1.3: Dynamics during MBS

ERBS: During most programs, the maximum growth rate of GDP is reached two years after money growth first declined. An analysis of the individual stabilization episodes reveals that GDP growth contracts only during the stabilizations in Bolivia and Costa Rica. However, MBS fares badly both in terms of short-run consumption and investment behavior: On average, both variables exhibit a strong decrease in the year of stabilization. The reduction in consumption growth occurs in five of the nine episodes considered, namely, in Bolivia, Costa Rica, Ghana, Kenya, and Nigeria. The post-stabilization periods, however, are characterized by positive consumption and investment growth.

The finding that GDP expands whereas consumption and investment contract in the year of stabilization is puzzling: By definition, GDP equals the sum of spending, that is, consumption, investment, net government expenditure and the primary current account balance.[45] As consumption and investment account for approximately 90 percent of GDP, negative growth rates of the magnitudes reported above are not compatible with positive GDP growth.[46] Part of the discrepancy might stem from the fact that data on the consumption and investment is not available for all stabilizations. A further explanation is deficient data quality. Plausibly assuming that overall GDP is measured most accurately, consumption and investment data might understate actual outcomes.

The above table does not report on current account dynamics, since most of the African countries lack reliable data. Calvo and Végh (1999:1554) report that there is "no clear-cut response of the trade balance and the current account. If anything, there seems to be a short-run improvement of the external balances." This is compatible with my finding that the increase in supply exceeds demand. Similarly, Hamann (2001) finds that the median current account of a sample of 34 episodes of MBS does not deteriorate during stabilization.

In sum, the empirical evidence indicates that MBS is not always contractionary: In terms of GDP growth, MBS is associated with a recovery, starting in the year of stabilization. Consumption and investment contract only during the year of stabilization and are followed by positive growth rates thereafter. On the basis of these results, the claim that choosing between ERBS and MBS amounts to choosing between 'boom now, recession later' and 'recession now and boom later' cannot be entirely supported. Nor can Easterly's finding that the initial expansions during ERBS and MBS are of equal magnitudes be confirmed. In light of these results, the appropriate wis-

[45]The balance of the primary current account equals the current account balance minus the net factor income accruing to foreigners.

[46]The consumption, investment and output growth rates in the year of stabilization reported in table 1.3 imply that the sum of net government spending and net foreign demand, weighted with their respective shares in GDP, grows at a rate exceeding six percent, which is not compatible with the data reported in row 10. This reasoning is based on the accounting identity $Y = C + I + G + PCA$, where Y, C, I, G, and PCA denote GDP, consumption, investment, net government expenditure and the primary current account balance, respectively. In growth rates, the identity can be written as $\frac{\Delta Y}{Y} = \frac{C}{Y}\frac{\Delta C}{C} + \frac{I}{Y}\frac{\Delta I}{I} + \frac{G}{Y}\frac{\Delta G}{G} + \frac{PCA}{Y}\frac{\Delta PCA}{PCA}$, where Δ denotes the difference operator. Solving this for $\frac{G}{Y}\frac{\Delta G}{G} + \frac{PCA}{Y}\frac{\Delta PCA}{PCA}$, assuming $\frac{C}{Y} = 0.7$ and $\frac{I}{Y} = 0.15$ and inserting the stabilization-period values of $\frac{\Delta Y}{Y}$, $\frac{\Delta C}{C}$ and $\frac{\Delta I}{I}$ yields $\frac{G}{Y}\frac{\Delta G}{G} + \frac{PCA}{Y}\frac{\Delta PCA}{PCA} = 6.76$.

dom seems to be that choosing between MBS and ERBS is choosing between 'boom now, recession later' and 'slow recovery of GDP now, (consumption) boom later'. It should be pointed out, however, that it might not be wise at all to cast the diverse stabilization experiences in such few words.

1.5 Explaining the Stylized Facts of ERBS - An Overview of the Theoretical Literature

The sections 1.3.1 and 1.3.2 presented the empirical regularities associated with ERBS. This section is dedicated at reviewing the theories advanced to explain the regularities. The initial consumption boom and output expansion are probably the most salient of these, and their explanation is an important feature of any model on the real effects of ERBS. A reduced-form model by Rodriguez (1982) explains the initial expansion with inflation inertia in an environment of perfect capital mobility: Perfect international capital mobility implies that investors' real returns are equalized across economies. Therefore, the domestic real interest rate can be expressed as the foreign nominal interest rate less the difference between expected domestic inflation and devaluation rates.[47] Rodriguez then assumes that devaluation expectations adjust instantly to the stabilized devaluation rate's level, whereas inflation expectations are adaptive. A perfectly credible ERBS thus generates a decrease in real interest rates, which, given the assumed reduced-form aggregate demand functions, raises demand. The contraction witnessed in the final stages of stabilization is modeled to stem from the cumulative real exchange rate appreciation which results when the inflation rate exceeds the devaluation rate. Rodriguez' model offers a simple explanation for the stabilization-induced demand cycle. However, empirical evidence shows that stabilization is frequently associated with real interest rate *increases* (see Végh 1992). Furthermore, Calvo and Végh (1994c) argue that Rodriguez' results cannot be reproduced with realistic parameter values in a framework based on an utility- and profit-maximizing representative agent. While the model can be criticized on the grounds of its simplicity, it captures an important feature of ERBS: sluggish adjustment of the inflation to the devaluation rate. This is neglected by many other models on the real effects of ERBS which assume purchasing power parity (PPP) for all goods, that is, instant equality between inflation

[47] Deriving the real interest rate from a simple international interest parity equation yields $r = i^* - (\pi^e - \varepsilon^e)$, where r denotes the real interest rate, i^* the nominal world interest rate, ε^e the expected devaluation rate, and π^e the expected inflation rate.

and devaluation rates.[48] Whenever this is assumed, the terms 'inflation stabilization' and 'devaluation rate stabilization' will be used interchangeably in what follows.

Another 'early' explanation, labeled the 'temporariness hypothesis', underscores the deficient credibility of ERBS, that is, the fact that private agents might (correctly) expect the stabilization to be transitory. The focus on credibility is natural, since it is a prominent explanation for the output cost associated with stabilizing moderate inflation (Kydland and Prescott, 1977; Barro and Gordon, 1983) and historic hyperinflations (Sargent, 1982a). Most frameworks designed to explain the real effects of ERBS model non-credible stabilization as transitory stabilization, that is, as a temporary devaluation rate reduction whose starting date and duration is fully anticipated by the public (Calvo,1986; Calvo and Végh, 1993, 1994b). Given a cash-in-advance constraint on consumption, temporarily lower inflation translates into a temporary decrease in the cost of consumption. Utility-maximizing agents respond by intertemporally substituting consumption into the low inflation period, which produces the post-stabilization consumption boom. Talvi (1997) extends this framework to explore the effect of temporary stabilization on the government budget. He shows that the consumption boom due to transitory stabilization can produce an initial increase in fiscal revenues, which – erroneously – makes stabilization appear 'sustainable'.

Another variant of the temporariness hypothesis relies on intergenerational wealth changes: Helpman and Razin (1987) analyze the wealth effect of transitory inflation stabilization in an overlapping generations model for which Ricardian equivalence does not hold (see Blanchard, 1985). A temporary fall in the inflation rate implies a temporary decrease in government seignorage revenues. Under the assumption that inflation stabilization is not accompanied by reduced government spending, the present generation's wealth increases at the expense of future generations. This wealth increase generates the observed consumption boom.

Recent contributions to the temporariness hypothesis – for example Calvo and Drazen (1998) and Mendoza and Uribe (1999a,b) – incorporate uncertainty about the end of stabilization. The latter embed Calvo's idea into a general equilibrium model where the peg ends with a publicly known, exogenous, time-variant probability. Expectations-driven nominal interest rate fluctuations then produce the observed real movements.

An empirical verification of the temporariness hypothesis gives a mixed account: Reinhart and Végh (1995a) find that it can explain the consumption boom during 4 out of the 7 episodes of ERBS considered.

[48] This follows from PPP when prices abroad are assumed to be constant.

The 'temporariness hypothesis' posits that a *transitory* fall in the inflation rate effects a *transitory* expansion. A third explanation applies this mechanism to *permanent* stabilization. In a cash-in-advance framework, permanently lower inflation rates imply permanently lower seignorage revenues for the government. In the previously reviewed models, the magnitude of seignorage revenues did not affect private agents' wealth, as seignorage was assumed to be fully redistributed to the private sector via lump-sum transfers. Alternatively, inflation can be modeled to reduce economy-wide wealth, which implies that inflation stabilization effects an increase in private agents' wealth and thus their consumption. These permanent wealth effects of inflation stabilization are explored by Calvo and Végh (1994b): In an economy where home or foreign cash must be used for transacting, lower domestic inflation reduces currency substitution and thus seignorage payments to the foreign central bank. This increase in domestic agents' wealth is assumed to contribute to the observed expansion. In order to explain the *magnitude* of the observed consumption boom, De Gregorio et al. (1998) additionally introduce discrete purchases of durable goods: They model the stabilization-induced wealth increase as resulting from reduced shopping time. The jump in wealth effects a bunching of durables purchases. Since durables are long-lived, the boom is followed by low spending on durables. Hence, the boom-recession cycle is part of a welfare maximizing equilibrium.

Another strand of the literature emphasizes the supply-side effects of inflation stabilization. Technically, these models are similar to those emphasizing the effect of permanent wealth changes on consumption. Instead of consumers, firms are now required to hold money for transacting, and instead of a consumption-driven output expansion, the consumption boom now results from increased production. Money is introduced via a cash-in-advance constraint on wage payments and investment (Roldos, 1995), or on intermediate goods purchases. The latter is assumed by Uribe (1997a) within a model of currency substitution: Firms buy intermediate goods subject to a domestic cash-in-advance constraint, but use foreign currency as a store of value. Changing foreign into domestic currency is associated with a fixed cost per transaction. Lower inflation reduces the optimal number of change transactions; these cost savings lead to increased production.

Other supply side-oriented theories focus on inflation's impact on credit market conditions.[49] Edwards and Végh (1997) and De Gregorio and Sturzenegger (1997) suggest possible links between inflation and credit supply. The

[49]Extending the analysis in this direction is natural, since parts of the literature on monetary transmission suggest that monetary policy and real variables are linked through liquidity and credit availability, see for example Bernanke and Blinder (1988).

former present a representative agent, general equilibrium model in which inflation stabilization reduces the cost of extending credit due to nominal reserve requirements on deposits. Credit demand arises from firms' credit-in-advance constraint on the wage bill; a reduction in credit costs lowers input costs and raises output. De Gregorio and Sturzenegger (1997) propose a partial equilibrium model of asymmetric information between borrowers and lenders: Two types of firms with differing productivities must finance their wage bill with bank credit. Banks cannot observe the firms' productivities, and rely on their labor demands as signals. The productivity differential – and thus the difference between the two firms' labor demands – is assumed to decrease in inflation. High inflation is therefore associated with an inefficient pooling equilibrium on the credit market and low total output, whereas inflation stabilization allows lenders to distinguish between high and low productivity firms and thus increases efficiency and total output.

The theories reviewed so far regard the inflation reduction during ERBS as causal for the observed real movements. Drazen and Helpman (1988), in contrast, emphasize the fiscal policy reforms accompanying ERBS as a determinant of the real expansion: Expectations of a future reduction in (unproductive) government spending increases private sector demand.[50] However, simulations by Rebelo and Végh find that a fiscal contraction in isolation cannot reproduce the main effects of ERBS.[51]

Finally, all but the last of the above theories have been criticized by Kydland and Zarazaga (1997) on the grounds that money and nominal variables might not matter at all. Kydland and Zarazaga argue that business cycle features of chronic inflation economies are similar to those of industrialized countries, and therefore explainable by standard RBC models. While Kydland and Zarazaga rightfully point out that simultaneity does not imply causality, their negation of the stylized facts of ERBS can be questioned on several grounds: Their assertion is based exclusively on an informal analysis of Argentinean data and not verified by calibrating a standard RBC model. Furthermore, Easterly (1996) finds the output recovery after 'growth crises' – defined as three consecutive years of negative per capita GDP growth – to be significantly stronger when coupled with inflation stabilization. The regression analysis by Calvo and Végh (1999) shows that the short-run expansion of output and consumption during ERBS remains significant when controlling for industrial countries' interest rates and GDP. Coupled with the literature

[50] This is similar to Giavazzi and Pagano's (1990) model of expansionary government spending contractions.

[51] Two variants of fiscal contraction are modeled: a permanent three percent decline in government expenditure on non-tradable goods and a permanent six percent decline in government expenditure on tradable goods.

surveyed in section 1.3.1 and my data analysis (section 1.3.2), this indicates that the stylized facts of stabilizing high inflation do indeed exist.[52]

So far, this account has focused on explanations for the initial consumption and output expansion. How do the theories explain the other major stylized facts, namely, the real exchange rate appreciation and the current account deterioration? The former is not reproduced by the early models, which assume PPP to hold for all goods. More recent models – for example Calvo and Végh (1993), Roldós (1995), Uribe (1997a), and Mendoza and Uribe (1999a,b) – regard the real appreciation as resulting from excess demand for non-tradable goods: The stabilization-induced demand increase is combined with temporarily inelastic supply of non-tradable goods due to sector-specific technologies and fixed factor endowments (Rebelo and Végh, 1995; Roldós, 1995), or adjustment costs and gestation lags in capital formation in the non-tradables' sector (Uribe, 1997a). Excess demand for non-tradables generates the real appreciation via increasing relative non-tradables' prices. Increased demand for tradable goods, in contrast, is partially satisfied with imported goods and thus engenders the current account deterioration.

So far, this survey has focussed on models of ERBS. The empirical evidence reported in section 1.4 indicated that MBS is also associated with a recovery of GDP. This raises the question of whether the models surveyed in this section – and those presented in chapters 3 and 4 of this dissertation – can be equally applied to explain the output expansion during MBS. The answer is positive for models which rely on wealth or supply side effects of permanently lower inflation rates. Analyzing MBS in these frameworks just requires assuming an exogenous path for nominal money growth, which, coupled with money demand, then determines the devaluation rate.[53] Theories based on the intertemporal price changes associated with transitory stabilization, in contrast, can only be applied to *heterodox* MBS which produce an immediate fall in inflation through direct price controls. The dynamics of non-credible, *orthodox* money and exchange rate-based stabilizations should be fundamentally different: If agents doubt the success of money-based stabilization, devaluation and inflation rates will remain at a high level. In ERBS, in contrast, the devaluation rate reduction is implemented exogenously and implies an instantaneous fall in import prices.

[52] More sophisticated methods for identifying the shocks which determine GDP and consumption fluctuations – as for example SVAR estimations along the lines proposed by Blanchard and Quah (1989) – cannot be sensibly applied to high inflation countries: Frequently, time series data for these countries covers only relatively recent years and can rightfully be suspected to be characterized by structural breaks.

[53] An analytical derivation of how these two variables are connected is presented in section 3.2.3.

This section reviewed a wealth of possible explanations for the real effects of ERBS. One would like to conclude this survey of the literature by final judgements about the validity of the competing theories: Is the consumption boom during ERBS a reflection of the wealth effects of *permanently* lower inflation, or is it private agents' shopping frenzy as they anticipate the return of high inflation? Answering this question is crucial for determining if the expansion is a sign of the stabilization's virtue – or of its failure. Recapitulating, two types of explanations can be distinguished: First, theories which model the stylized facts as characteristic of stabilizations perceived to be transitory. These rely on intertemporal price changes, and view the expansion as (mainly) consumption-driven. Second, theories which posit stabilization to be credible and permanent, and emphasize its positive supply-side or wealth effects. Based on this distinction, some of the above- reviewed theories can be positioned in the following classification scheme:

<table>
<tr><th></th><th>Supply</th><th>Consumption</th></tr>
<tr><td>Permanent stabilization</td><td>Roldòs (1995), Uribe (1997a), De Gregorio and Sturzenegger (1997), Edwards and Végh (1997)</td><td>De Gregorio et al. (1998)</td></tr>
<tr><td>Transitory stabilization</td><td></td><td>Calvo (1986), Helpman and Razin (1987), Calvo and Végh (1993, 1994b), Talvi (1997)</td></tr>
<tr><td></td><td colspan="2">Mendoza and Uribe (1999a,b)</td></tr>
</table>

Dissimilar modeling frameworks and degrees of abstraction preclude a direct comparison of how different theories fare at explaining the stylized facts of ERBS.[54] Therefore, the subsequent discussion of the respective models' merits must be conducted on an informal level. It should be pointed out that the discussion in what follows, and the above classification scheme, neglects Sargent's (1982b) critique that modern macroeconomics is "beyond demand and supply curves" – my impression of the literature on the stylized facts of ERBS is that many models still work within these categories.

What would one expect as the distinguishing features of a demand- versus a supply-driven expansion during ERBS? Based on economic intuition, the

[54]For example, most older demand-side models assume GDP to be constant, while more recent work endogenizes both GDP and consumption. Other differences arise from particularities in modeling the financial sector, consumer goods and the connection between monetary and real variables.

former should be associated with smaller increases in the capital stock, employment and inventories, a larger current account deficit and higher prices. If non-tradables' prices are more demand-sensitive than tradables' prices – which is plausible – the real appreciation should be more pronounced during a demand-driven boom. What are the distinguishing features of a stabilization effort expected to be temporary versus one considered as credible and permanent? In light of the existence of recruitment and firing costs, a temporary devaluation rate reduction is likely to be associated with a less pronounced increase in employment than in permanent stabilization. Furthermore, if price setters are forward-looking, reducing the inflation rate should be harder if stabilization is perceived to be temporary. The evidence presented in sections 1.3.1 and 1.3.2 shows that ERBS is typically accompanied by (at most) a moderate rise in investment and inventories, a sustained current account deterioration and a pronounced real appreciation. Unemployment falls only temporarily during ERBS, also during relatively long-lived stabilizations. Furthermore, the decrease in the unemployment rate is below one percentage point for most stabilizations. If the above reasoning contains some truth, these empirical findings underline the importance of demand fluctuations and agents' expectations of stabilizations' transitoriness.

The only systematic theoretical comparison of the effects of temporary and permanent stabilization is due to Rebelo and Végh (1995). They model ERBS in a two-sector specific-factor economy[55] where 'money matters' because of transaction costs. These increase symmetrically in consumption and investment, decrease in real balances, and reduce economy-wide wealth. The model is calibrated to match average values of key ratios of the Argentine economy in the decade prior to the 1991 currency board. Then, the effects of a permanent and 10-quarter 100 percent decline in the nominal devaluation rate are simulated over 10 years. Before discussing the results, it should be noted that Rebelo and Végh's framework differs from most models reviewed in this section and the one implicitly underlying the above informal discussion: Investment and consumption are modeled to be equally affected by inflation, precluding a comparison of the supply and demand-side effects of stabilization. Furthermore, given that the specification of transaction costs implies that economy-wide wealth decreases in the inflation rate, both temporary and permanent stabilizations are associated with permanent wealth effects. In light of these differences, it is little surprising that Rebelo and Végh's results are unlike those derived in above informal reasoning: Their

[55]In addition to labor, the production of non-tradable and of tradable goods uses land and (tradable) capital, respectively. Labor is mobile between sectors, and investment subject to adjustment costs.

simulations find temporary stabilization to be accompanied by a weaker increase in consumption, a stronger jump in investment, and a less pronounced initial current account deterioration than permanent stabilization. The real exchange rate appreciates about the same magnitude. The model's numerical fit is mixed: The maximum deviation of non-tradables consumption from its pre-stabilization levels reaches 5 and 8 percent in temporary and in permanent stabilization, respectively; those of tradables consumption 8.5 and 14 percent. While this is in line with the data, the increase in investment greatly exceeds what is actually observed: Its maximum deviation from the pre-stabilization level amounts to 60 percent during temporary, and 39 percent during permanent stabilization. The magnitude of the observed real appreciation cannot be endogenously reproduced – a scenario with nominal rigidities produces realistic results, but exogenously *assumes* the path of relative prices of tradable goods.

What can be learned from Rebelo and Végh's exercise? From a policy perspective, their results are disappointing: Both transitory and permanent stabilization are found to be accompanied by similar initial dynamics, which implies that these provide little evidence on agents' beliefs concerning the duration of stabilization. According to Rebelo and Végh's results, we do not know if a policymaker witnessing an initial consumption boom during ERBS should congratulate or sack his advisors, tax consumption or remain idle. Rebelo and Végh's approach can be criticized along several other lines: First, their modeling framework might not be adequate for emerging economies – Baxter (1995:175) notes that "Rebelo and Végh do not tell us enough about (...) these economies for us to be able to evaluate whether the particular specific-factors model they have chosen may be adequate for the job at hand." Also, one would like to see some sensitivity analysis, in particular with respect to the parameters determining capital installation costs, transaction costs and the intertemporal elasticity of substitution. Empirical estimates for high inflation economies have produced wide ranges for these parameters, as documented by Reinhard and Végh (1995a:366) and Agenór and Montiel (1996:353) for the intertemporal elasticity of substitution. If slight variations within the range of realistic parameter values produces discordant results, the model 's prediction are not of great help for policy makers who simply do not know which parameter value is the right one.

Finally, Rebelo and Végh's numerical solution technique raises some issues, as it involves linearizing around a steady state the economy never returns to: Given the constant real interest rate, any transitory shock permanently changes consumption and wealth (Giavazzi and Wyplosz, 1984). Furthermore, calibration assumes constant first moments of specific variables or ratios. Key ratios of the Argentine economy during the high-inflation years from 1981 to 1991 might differ substantially from values during the prolonged period of low inflation in the aftermath of the 1991 Convertibility Plan.[56]

To recapitulate: As for now, we do not know which of the theories on the real effects of ERBS offers the 'winning formula'. My guess is that there simply is no single winning theory – if it had to be named, I would put three features on the pedestal: the credibility of stabilization, the demand for durable goods, and 'market imperfections', in particular on domestic goods and labor markets and international capital markets. This last feature is discussed in the next section.

1.6 Motivation of my Research and Overview of the Dissertation

Despite the proliferation of theories designed to explain the real effects of inflation stabilization in developing economies, the recent literature has widely ignored imperfections: Most optimization-based models assume perfect goods, factor and capital markets; cash-in-advance constraints or similar mechanisms of introducing money are the only deviations from frictionless real economies. This stands in contrast to what is the state of the art in open-economy macroeconomics, and to recent empirical findings.[57] Obstfeld and Rogoff (1996:606), for example, observe:

> "For anyone who looks even casually at international data (...) the idea that nominal price rigidities are irrelevant seems difficult to sustain."

Similarly, Edwards (2002) argues in the context of currency crises that

> " 'equilibrium models' of frictionless economies are of little help to (...) assess a country's degree of vulnerability [to financial crises]."

The unifying feature characterizing the models presented in this thesis is the relaxation of 'assumptions of perfection', namely, the assumptions of perfect price flexibility and perfect international capital mobility. This focus is motivated by two considerations: First, the abundant empirical evidence on

[56] Real variables fluctuate widely in high inflation economies: The standard deviation of Argentine real GDP growth between January 1968 and April 1997, for instance, exceeds average annual real GDP growth during that period by more than five times (5.16 percent versus 0.69 percent).

[57] On the former, see for example Lane's (2001) survey of the so-called 'New Open Economy Macroeconomics'.

these phenomena, and second, the failure of the existing optimization-based models to explain salient features of ERBS.

With regard to *price stickiness*, empirical studies – for example Sheshinsky et al. (1981), Lach and Tsiddon (1993), and Tommasini (1993) – show that high inflation greatly increased the variability of relative prices in Argentina and Israel. This reflects the existence of nominal rigidities in high inflation economies – under perfect price flexibility, all individual price changes should be perfectly synchronized with the overall inflation rate.[58] Rebelo and Végh (1995), Ambler and Harb (1999), and Celasun (2000) find that assuming exogenous price or wage stickiness greatly improves the quantitative performance of calibrated models of ERBS. Ambler and Harb (1999), for example, introduce stochastic partial adjustment of nominal wages into a general equilibrium model of permanent ERBS. Their simulation results match the real effects of heterodox ERBS, in particular consumption and real exchange rate dynamics, better than a model without nominal rigidities. Nevertheless, little effort has been devoted to further exploring and modeling the nature of price stickiness. This gap in the existing research motivates the model presented in **Chapter 3**. It introduces monopolistic competition and sticky prices in a framework of transitory exchange rate targeting, in which the end of stabilization is modeled as a fully anticipated devaluation rate increase. Only the economy's non-tradable goods sector is characterized by price stickiness: Non-tradable final goods are assembled using a continuum of monopolistically produced non-tradable intermediate goods. Prices of these inputs are sticky in the sense that they can only be changed every other period. The price stickiness allows to explain the real appreciation witnessed during transitory ERBS with forward-looking price setting: As an expected future devaluation rate increase is incorporated in current prices of non-tradable goods, relative non-tradables' prices rise and the real exchange rate appreciates during temporary stabilization. Furthermore, the model is able to reproduce two other salient stylized facts of ERBS, namely, the consumption boom and the current account deterioration. While the former results from intertemporal price changes and the resulting intertemporal substitution of demand (as in Calvo 1986), the latter stems both from intertemporal price level changes and the increase in relative non-tradables' prices. An extension of the model shows that its main results remain valid when overlapping price contracts à la Taylor are introduced. The model's implications for movements in the relative price of non-tradable goods are then empirically tested and confirmed with Mexican data: OLS estimations based on disaggregated monthly prices from

[58] Also, direct evidence on price stickiness in industrialized economies abounds; see for example Blinder et al. (1998).

August 1975 to May 2000 reveal that the relative price of non-tradable goods actually incorporates expected devaluation rate changes, that is, an expected devaluation rate increase is reflected in a higher relative price of non-tradable goods.

The above framework models the real appreciation as a result of variation in relative non-tradables' prices. The validity of this assumption has been cast into doubt by recent empirical evidence, which reports that the relative price of non-tradable goods contributes very little to the observed real exchange rate fluctuations.[59] Therefore, as a first step in the analysis of real exchange rates during ERBS – and as a further contribution to the research on its stylized facts – **Chapter 2** explores the *origin* of real exchange rate fluctuations in Brazil. To this aim, Engel's (1999, 2000) method of real exchange rate variance decomposition is applied. This allows to assess what fraction of real exchange rate fluctuation is due to relative prices of non-traded goods and what fraction can be accounted for by exchange-rate adjusted prices of traded goods. The analysis reveals that both components are about equally important determinants of real exchange rate fluctuations during ERBS. When analyzing the full sample from January 1981 to May 2001, however, changes in traded goods' prices and the nominal exchange rate account for almost all of the real exchange rate movements; a result similar to what was found for industrialized countries. An informal analysis of disaggregated non-tradables' prices shows that their increase during ERBS is the driving force behind the result. Coupled with Mendoza's (2000) evidence on Mexico, the increased contribution of relative non-tradables' prices to the observed real exchange rate fluctuations apparently constitutes an additional stylized fact of ERBS.

In short, Chapters 2 and 3 provide answers to the following questions: First, do relative prices of non-tradable goods play a role for the real exchange rate appreciation witnessed during ERBS, and for real exchange rate fluctuations in chronic inflation economies in general? As this first question is affirmed by my empirical analysis, the second question is: Why do relative non-tradables' prices change during transitory stabilizations, that is, why does the real appreciation occur?

Chapter 4 offers an answer to the question of how the collapse of ERBS is connected to the stabilization's initial dynamics. The model presented in this chapter explains both features with self-fulfilling expectations about the duration of the peg and post-stabilization monetary policy. A crucial element of this explanation is the assumption of *partial international capital mobility*, modeled as an upper ceiling on the domestic economy's net foreign liabilities.

[59]See for example Engel (1999) or Chari et al. (1998) on real exchange rates in industrial countries, and Engel (2000) on Mexican real exchange rates.

This feature is motivated by the extensive empirical evidence on imperfect international capital mobility, in particular, on emerging economies' restricted access to international capital. Lane and Milesi-Ferretti (2002), for instance, find that international borrowing by developing economies is subject to constraints which are stricter than implied by intertemporal solvency. Based on a cross-section of 45 developing economies, they show that net foreign borrowing increases in current output, and interpret this result as evidence for the existence of financial constraints.[60] Gelos and Werner (1999) report that around 60 percent of loans in Mexico are collateralized, which implies that a large fraction of borrowers cannot obtain credit against their future wealth – as assumed in most macroeconomic models – but only against current wealth.

My model underlines the role of international borrowing constraints for currency crises. This has been empirically investigated by Calvo and Reinhart (1999), who find that currency crises are associated with major contractions in international credit. Likewise, my empirical analysis in section 1.3.2 shows that devaluation crises in the aftermath of stabilizations are accompanied by a pronounced reduction in portfolio investment inflows. Edwards (2002) finds a positive correlation between the current account deficit and the probability of a currency crisis for a large sample of industrialized and developing economies. As current account deficits are, per definition, associated with reserve losses or capital account surpluses, these increase the probability of currency crises. My own cursory data analysis suggests that the collapse of ERBS is associated with debt-to-GDP ratios in excess of 40 percent: The Argentinean currency board collapsed when foreign liabilities reached 48 percent of GDP; prior crises in Argentina (in 1982 and 1987) and Brazil (in 1987) were associated with debt-to-GDP ratios of 52, 53 and 41 percent, respectively. Turkish foreign debt amounted to around 80 percent of its GDP when the exchange rate peg was abandoned in February 2001.[61] Furthermore, rules of thumb for debt sustainability (see for example Williamson 1993) suggest the existence of an upper limit of foreign indebtedness.

The model presented in Chapter 4 incorporates a borrowing constraint which imposes an exogenous upper ceiling on the ratio of foreign debt to GDP. This constraint is added to a standard model of a small, open economy in which agents consume and produce a single homogenous good subject to cash-in-advance constraints. The model allows to show that both the initial expansion during ERBS and the stabilization's temporariness can result from self-fulfilling expectations about the peg's duration and post-stabilization

[60] Particularly as this evidence stands in contrast to their finding for *industrialized economies*, where the relation between output and the net foreign asset position is *positive*.

[61] The ratios are based on data from the Word Bank, the *Frankfurter Allgemeine Zeitung* (28.12.01), and *The Economist*.

monetary policy: If agents expect the ERBS to be temporary, they take advantage of temporarily lower cash prices by increasing consumption in excess of output. The resulting current account deficits – which are financed with capital imports – imply that the upper bound of foreign debt is eventually reached. Further current account deficits then engender a reduction in central bank reserves, which eventually culminates in the peg's collapse. This does not occur if agents judge the stabilization as credible and expect inflation and devaluation rates to remain permanently at the lower levels. Given these expectations, agents consume and produce a constant amount each period, which implies that the economy's borrowing constraint does not become binding and the peg can be upheld indefinitely. The chapter's novelty is that it offers a link between the initial dynamics of ERBS and their collapse. Despite the overwhelming empirical evidence on the transitory nature of ERBS, the existing literature is silent on its connection with the initial real dynamics.

Finally, **Chapter 5** concludes by pointing out some policy implications which can be drawn from this dissertation.

To summarize, the topic of this dissertation is the role of price stickiness and partial capital mobility in generating the real dynamics associated with non-credible ERBS and their (self-fulfilling) termination. The analyses are conducted in deterministic optimization-based, representative agent models of small open economies. The models' implications are derived analytically, thus evading the pitfalls of calibrating models of open high inflation economies. The theoretical analysis is complemented by empirical assessments of the determinants of real exchange rates and relative non-tradables' prices during ERBS.

1.7 Appendix

1.7.1 Summary of the Empirical Literature on the Stylized Facts of ERBS

If not specified otherwise, the ERBS considered in the publications summarized below stem from the sample of stabilizations in Argentina (1967, 1978, 1985), Brazil (1964, 1978), Chile (1970, 1973, 1978, 1985), Israel (1985), Mexico (1987), Peru (1986), and Uruguay (1968, 1978).

Publication	Programs	Findings
	Case studies surveys	
Agenòr and Montiel (1996)	7 ERBS and MBS in Latin America and Israel	Boom-bust cycle for both heterodox and orthodox ERBS Initial recession and improvement of external balances for orthodox MBS
Végh (1992)	10 ERBS in Latin America and Israel	Increase of real activity at beginning of program, later contraction Slow convergence of inflation rate to rate of devaluation Real appreciation Current account deterioration
	continued on next page	

Publication	Programs	Findings
Calvo and Végh (1994a)	11 ERBS in Latin America and Israel, 5 MBS in Latin America	**ERBS**: Consumption boom in first year of stabilization Slow convergence of inflation rate to rate of devaluation Real appreciation Current account deterioration Real interest movements heterogenous **MBS**: Decrease of consumption in first year of stabilization Slow convergence of inflation rate: Rate of money growth in last quarter of stabilization for most programs higher than inflation rate Real appreciation Constant or improvement of current account balance Sharp increase in real interest rates
Kiguel and Liviatan (1992)	12 ERBS in Latin America and Israel	Rise in GDP in first year of stabilization Current account deterioration Real exchange rate appreciation Effects on real wages heterogenous
Cross-country averages (based on relatively large samples)		
Easterly (1996)	Pooled sample of 18 MBS (of which 5 Latin America, 7 Africa) and 9 ERBS (7 Latin America)	For both MBS and ERBS: Positive growth of real GDP and consumption after stabilization Supply side: First increased capacity utilization and productivity increases, later on rise in investment
Hamann 2001	21 MBS, 13 ERBS	See section 1.3.1

continued on next page

Publication	Programs	Findings
Fischer et al. (1996)	26 Transition economies	Cumulative output loss greater in MBS than during ERBS
Studies focussing on one particular variable		
Focus on durable goods		
De Gregorio et al. 1998	7 ERBS: Argentina (1978, 1991), Chile (1978), Israel (1985), Uruguay (1978, 1990), and Mexico (1987)	Boom in durables consumption in 3 years following stabilization; decline of durables consumption growth in years 4 and 5, with negative growth rates for failed programs.
Focus on credit		
Copelman (1996)	ERBS in Chile (1978), Israel (1985), Mexico (1987)	Credit expansion during stabilization
Khamis (1996)	ERBS in Argentina (1978), Chile (1978), Israel (1985), Mexico (1987)	Credit expansion during stabilization
De Gregorio and Sturzenegger (1997)	MBS: Bolivia (1985) ERBS: Argentina (1991), Mexico (1987)	Banks' credit to private sector expands as inflation falls

1.7.2 Inflation Stabilization Programs in High Inflation Economies

Please note that this listing does not claim to cover all programs of inflation stabilization in high inflation economies.

Exchange Rate Based Stabilizations (ERBS)

Latin America

Country	Starting Date, Duration	Program Design
Argentina	1959.3 - 1962.2	
Argentina	1967.3 - 1970.5	Fixed exchange rate
Argentina	1973.3 - 1975.2	
Argentina	1978.12 -1981.1	Crawling peg (Tablita)
Argentina Austral Plan	1985.6 - 1986.3	Heterodox crawling peg
Argentina Peso Plan	1991.4 - 2002.1	Currency board
Brazil	1964	Heterodox, gradualist stabilization
Brazil Cruzado Plan	1986.2 - 1986.11	Heterodox peg
Brazil Real Plan	1994.6 - 1999.1	Peg, crawling peg to US dollar
Chile	1970 - 1973	
Chile	1978.2 - 1982.6	Crawling peg, peg to US dollar)
Ecuador	1992 - 1998	Crawling peg to US dollar
Ecuador	2000.4	Adoption of the US dollar as official currency
El Salvador	2001.1	Adoption of the US dollar as official currency
Mexico	1987.12 - 1994.12	see chapter 3
Nicaragua	1990	

continued on next page

ERBS in Latin America		
continued from previous page		
Country	Starting Date, Duration	Program Design
Peru	1986 - 1990	Multiple fixed exchange rates
Uruguay	1968.6 - 1971.12	Fixed exchange rate
Uruguay	1978.10 - 1982.11	Pre-announced crawling peg
Uruguay	1990.12 - 2002.7	Exchange rate band
Venezuela	1997 - 2002.2	Exchange rate bands to US dollar

Transition Economies (Eastern Europe and former Soviet Union)

Country	Starting Date	Program Design
Bulgaria	1997.7 - present	Currency board with German mark/euro
Czech Republic	1992.1 - 1997.6	Crawling peg to basket of currencies
Croatia	10.1993	
Estonia	20.6.1992 - present	Currency board with German mark/euro
Hungary	1990.3	Crawling peg
Hungary	1995.3	Pre-announced crawling peg
Slovak Republic	1992.11	Exchange rate band to basket of currencies
Yugoslavia	1990	Peg to the German mark/euro
Lithuania	1994.2 - present	Currency board with US dollar, currency board with Euro
Poland	1990.1	Peg to US dollar, crawling peg to basket of currencies, crawling band
continued on next page		

ERBS in Transition Economies		
continued from previous page		
Country	Starting Date	Program Design
Macedonia	1994.1	

Other countries

Country	Starting Date	Program Design
Egypt	8.10.1991 - present	Exchange rate band to US dollar
Iceland	1983 - 1988	
Israel	1982 - 1983	
Israel	1985.7 - present	Peg, crawling peg, gradual transition to inflation targeting
Turkey	1958 - 1970	Peg to US dollar
Turkey	1.2000 - 2.2001	Crawling peg to US dollar

Money Based Stabilizations

Stabilizations of post-World War I hyperinflations

Country	Date of Stabilization
Austria	1922.9
Germany	1923.12
Hungary	1924.3
Poland	1924.2
Russia	1924.2

Latin America and Caribbean

Country	Starting Date (Duration)
Argentina BB Plan	1988 - 1989
Argentina Bonex	1990.1 - 1990.4
Argentina	1992.1
Bolivia	1985
Chile	1973
Chile	1975.4
Costa Rica	1982
Dominican Rep.	1990.3 - 1992.4
Jamaica	1991
Peru	1990.8 - 1992.2
Uruguay	1972 - 1976

Transition Economies (Eastern Europe and former Soviet Union)

Country	Starting Date (Duration)
Albania	1992
Bulgaria	1991 - 1992
Kazakhstan	1994 - 1995
Romania	1991 - 1992
Russia	1993.3 - 1994.1
Slovak Republic	1991.10
Ukraine	1994 - 1995

Other Countries

Country	Starting Date (Duration)
Ghana	1983
Guinea-Bissau	1992
Kenya	1991
Iceland	1974
Indonesia	1966
Nigeria	1988
Sierra Leone	1991
Somalia	1980
Somalia	1984
Turkey	1980
Turkey	1994 - 1995
Turkey	1998.1
Turkey	2001.5
Uganda	1987
Uganda	1980
Zaire	1983

Sources:
Agenór and Montiel (1996), Annual Reports of the *European Bank for Reconstruction and Development*, Calvo and Végh (1999), Cardoso and Dornbusch (1987), Dornbusch and Werner (1994) Dibooglu and Kibritcioglu (2001), Easterly (1996), Fischer, Sahay and Végh(1996), Heyman (1987), *IMF Economic Review*: Estonia (1994), *IMF World Economic Outlook* (May 2001), Kiguel and Liviatan (1992 and 1995), Krueger (1995), Sachs (1987), Sargent (1982a), Schultz (2002), Schweickert (1994), *OECD Economic Survey*: The Slovak Republic (1996) and Végh (1992).

1.7.3 Data

Source for most variables are the *International Financial Statistics* (*IFS*). The numbers in brackets indicate the IFS classification number of the respective variable.

- Inflation rate: Changes in consumer prices, % per annum (*IFS*: 64 X)
- Devaluation rate: Calculated from market rate, domestic currency/US dollar (*IFS*: RF)
- Real consumption growth (*IFS*: 96F, in domestic currency)
- Real GDP growth (*IFS*: 99BP, constant prices)
- Unemployment rate, in % (*IFS*: 67r)
- Real investment growth: Private gross fix capital formation (*IFS*: 93e)
- Inventories: (*IFS*: 93i)
- Annual change in the current account balance, in percent (*IFS*: 78ald)
- Annual change in the financial account balance, in percent (*IFS*: 78 bjd)
- Net portfolio investment assets:

Calculated as portfolio investment assets (*IFS*: 78 bfd) minus portfolio investment liabilities (*IFS*: 78 bgd)

- Average capacity utilization - Brazilian manufacturing industry: Central Bank of Brazil

- Deposit money banks' claims on the private sector (millions of domestic currency)(*IFS*: 32D)
- Money (*IFS*: 14)
- Government budget deficit (*IFS*: 80)
- Government revenue (*IFS*: 81)
- Government expenditures (*IFS*: 82)
- Interest rates spreads: Calculated from
  - Deposit rate, percent per annum (*IFS:* 60L)
  - Lending Rate, percent per annum, (*IFS:* 60P)
- US GDP deflator (*OECD Main Economic Indicators:* 421051KSA, 1995=100)

Chapter 2

Determinants of the Real Exchange Rate across Exchange Rate Regimes: Evidence from Brazil

2.1 Introduction

The previous chapter presented evidence on the real appreciation typically witnessed during ERBS. This chapter aims at identifying the *origin* of this real appreciation – and of real exchange rate fluctuations in general – using the Brazilian-US real exchange rate as an example. Applying Engel's (1999, 2000) method of real exchange rate variance decomposition, I assess what fraction of real exchange rate variation can be attributed to variations in relative prices of Brazilian non-tradable goods, and what fraction to variations in cross-country tradable goods' prices, denominated in Brazilian currency.

Interest in the origin of real exchange rate fluctuations during ERBS is justified by the following considerations: First, the effectiveness of ERBS as a means of stabilizing inflation depends on the magnitude of nominal exchange rate pass through. If nominal exchange rate fluctuations have little effect on domestic tradables' prices, pegging the exchange rate is not an effective tool for halting inflation. Thus, the design of inflation stabilization, and particularly the choice of a nominal anchor, should take into account the degree of nominal exchange rate pass through.

Second, the real appreciation is frequently held responsible for the breakdown of stabilization. Dornbusch (1996:1) states that

> "large real appreciations (...) will invariably run into trouble. Just

> when and how the crisis comes about will of course depend very much on the circumstances."

Similarly, Calvo and Végh (1999:1563) point out that fixed exchange rate regimes can be associated with the

> "problem of 'overvaluation' and the public's expectations that a corrective devaluation would have to take place at some point to restore 'equilibrium' prices."

Finally, Paul Krugman (2002) comments as follows on the Argentinean currency board:

> "Why can't the currency board survive? It is clear that Argentina suffers from a real overvaluation - that is, prices are too high given the exchange rate."

Similar concerns have been voiced by Dornbusch and Werner (1994), and empirically confirmed by Goldfajn and Valdes (1999). Given this connection between real exchange rate dynamics during ERBS and its termination, understanding what drives the real appreciation is crucial for effective crisis prevention. As discussed in Chapter 1, the models on ERBS assume the law of one price to hold, and attribute the real appreciation to increases in the relative price of non-tradable goods. This follows most standard theories, where, as emphasized by Obstfeld and Rogoff (2000), a role for cross-country prices of traded goods in real exchange rate determination is largely absent.[1] This chapter is devoted to analyzing the validity of this assumption. The next section surveys previous research on real exchange rate variance decompositions and real exchange rates in developing economies. Section 2.3 reviews the method of real exchange rate variance decomposition, and section 2.4 presents results for the Brazilian-US real exchange rate. Section 2.5 summarizes the main finding and points out some implication for models of ERBS.

2.2 Previous Research on Real Exchange Rate Determinants

The focus of this chapter is on assessing the determinants of real exchange rate fluctuations during ERBS, that is, determinants of short to medium run

[1] See for example the classic explanations for real exchange rate fluctuations by Balassa (1964) and Samuelson (1964).

real exchange rate movements. Therefore, the extensive empirical literature on the long run properties of the real exchange rate, specifically tests of PPP, is not considered in detail; the reader is referred to surveys by Rogoff (1996) or Mark (2001, Chapter 7). Both report ambiguous evidence concerning the long-run validity of PPP. It therefore comes as little surprise that evidence on short to medium run real exchange rate fluctuations disproves PPP and attributes most of real exchange rate fluctuations to cross-country differences in exchange rate-adjusted traded-goods' prices. The most comprehensive study in this context is by Engel (1999), who analyzes different measures of US-Canadian, US-Japanese, and US-European real exchange rates. He finds that cross-country differences in exchange rate-adjusted traded-goods' prices account for nearly all the variance of real exchange rates. For example, almost 100 percent of the Mean Squared Error (MSE) of the 5-year change in US-European and US-Japanese real exchange rates is due to the MSE of the traded-good component.[2] Even when excluding periods of flexible exchange rates, the traded goods component still explains over 85 percent of the total MSE.

In sum, Engel's study reveals two important characteristics of industrialized countries' real exchange rates: First, the variation of the relative price of non-tradable to tradable goods within a country accounts for only a very small fraction of total real exchange rate variation. Second, this holds true even when focussing on fixed exchange rate regimes. These findings are confirmed by other empirical studies on medium-run real exchange rate determinants in industrial countries, which are summarized in appendix 2.6.1.

The short and medium run determinants of real exchange rate fluctuations in *developing economies* have been researched little. Engel (2000) analyzes the US-Mexican real exchange rate from September 1991 to August 1999 and reports evidence very similar to that on industrialized economies: The contribution of exchange rate adjusted cross-country tradable goods' prices to the total real exchange rate variance is slightly below 90 percent at a 14-months horizon, and almost 100 percent for shorter horizons. Changes in relative tradables' prices – "the channel implicit in almost all theoretical models of real exchange rate behavior for Latin America" (Engel, 2000:8) – seems of little importance.Likewise, Burnstein, Neves and Rebelo (2000) find that only 4.7 percent of the real appreciation witnessed during the first two years of the Argentinean currency board are due to changes in relative non-tradable goods' prices.

This evidence is partially refuted by Mendoza (2000), who reconsiders the

[2]The Mean Squared Error of a variable z is defined as the sum of its variance and its squared mean, $MSE(z) = var(z) + mean(z)^2$.

Mexican case with data on prices of durables as tradables and non-durables as well as services as non-tradable goods. In an extension of Engel's analysis, he performs separate variance decompositions for the full sample (from January 1969 to February 2000) and for periods of fixed, managed and flexible exchange rates. The real exchange rate decomposition over the full sample confirms Engel's results: The contribution of cross-country tradables' prices to total real exchange rate fluctuations never falls below 92 percent for horizons of up to 24 months. During fixed and managed exchange rate regimes, however, it amounts only to 29 and 52 percent, respectively. This indicates the important role of relative non-tradables' prices during ERBS, and suggests that determinants of real exchange rate fluctuations differ across exchange rate regimes. Similarly, Lane and Milesi-Ferretti (2000) report evidence that real exchange rate movements in developing countries result from changes in the relative price of non-tradable goods.

Differences between Mendoza's and Engel's findings might partly be due to differing assumptions underlying the statistical analysis, in particular the definitions of the respective variance ratios. The following section explores this issue by reviewing the intuition of real exchange rate variance ratios and presenting different possibilities for their computation.

2.3 The Method of Real Exchange Rate Variance Decomposition

This section follows Engel (1999) in producing measures of the importance of movements in cross-country traded goods' prices for the overall variation of the real exchange rate. The starting point is the real exchange rate, defined as the ratio of foreign to home price indices, both expressed in the home currency. The log of the real exchange rate is given by

$$q = p^* + e - p, \tag{2.1}$$

where p and p^* denote the log of the home and the foreign country's price levels, respectively, and e the log of the nominal exchange rate. The home country's price level is a geometric average of traded goods' and non-tradable goods' prices, denoted p_T and p_N. Its logarithm can be expressed as a weighted (arithmetic) average:

$$p = \gamma p_N + (1 - \gamma) p_T. \tag{2.2}$$

Letting starred variables represent the foreign values, the log of the foreign country's price level is given as

$$p^* = \gamma^* p_N^* + (1 - \gamma^*) p_T^*, \tag{2.3}$$

where γ and γ^* denote the weights of non-tradable goods in the home and foreign country's overall price index, and p_N and p_T^* non-tradables' and tradables' prices at home and abroad. Substituting (2.2) and (2.3) in (2.1), the real exchange rate can be reformulated as

$$q = [e + p_T^* - p_T] + [\gamma^*(p_N^* - p_T^*) - \gamma(p_N - p_T)] \, .$$

To simplify the notation, this is rewritten as

$$q = x + y$$

where x is defined as

$$x \equiv [e + p_T^* - p_T]$$

and y as

$$y \equiv [\gamma^*(p_N^* - p_T^*) - \gamma(p_N - p_T)] \, .$$

x denotes the log of the ratio of traded goods' prices in the foreign and the home economy, both expressed in home currency. y is a weighted difference between the relative prices of non-tradable goods in each country. Both q and x exhibit high persistence, indicating that the variables might not be stationary in levels. Therefore, the real exchange rate was tested for stationarity using the Dickey-Fuller (DF) test (Dickey and Fuller, 1979).[3] Under the test's null hypothesis, the time series contains a unit root, that is, its first differences are stationary. The decision criterion is to reject the null hypothesis if the absolute value of the standard t-statistic is greater than the absolute value of the critical value at some desired level of significance reported by Fuller (1976). The test results, based on 243 monthly observations of real exchange rates (in logarithms), indicate that the null hypothesis of a unit root cannot be rejected at a 1 percent significance level – the t-statistic is -1.385, the corresponding critical value -3.463. This suggests that the real exchange rate data must be first-differenced in order to obtain a stationary series. It should be noted, however, that the test result should be interpreted with caution, as in small samples unit root tests have low power distinguishing between series that are non-stationary and series that are stationary but highly persistent (Canzoneri et al. 1999).[4]

In view of the test results, the following analysis is based on changes. The change of the real exchange rate over n periods is given as

$$q_t - q_{t-n} = x_t - x_{t-n} + y_t - y_{t-n} .$$

[3]The DF-test was chosen instead of the augmented DF-test since lagged differences failed to be significant.

[4]Unit root tests based on several centuries of real exchange rate data, for example Lothian and Taylor (1996), frequently find stationarity.

In the following, I assess how much of the variance of the change of the real exchange rate between periods $t-n$ and t, $q_t - q_{t-n}$, is due to the variance of $(x_t - x_{t-n})$, that is, cross-country traded goods' prices. The variance of $(q_t - q_{t-n}) \equiv \Delta_n q_t$ can be decomposed into the following components:

$$var\left(\Delta_n q_t\right) = var(\Delta_n x_t) + var(\Delta_n y_t) + 2cov\left(\Delta_n x_t, \Delta_n y_t\right),$$

where $\Delta_n x_t \equiv (x_t - x_{t-n})$ and $\Delta_n y_t \equiv (y_t - y_{t-n})$. The total contribution of $\Delta_n x_t$ to the variance of $\Delta_n q_t$ depends on how much of the covariance between $\Delta_n x_t$ and $\Delta_n y_t$ is attributed to $\Delta_n x_t$.

How much of the covariance *should* be attributed to $\Delta_n x_t$? This question cannot be unequivocally answered, as neither economic intuition nor statistics tell us what fraction of the covariance is *truly* due to variations in $\Delta_n x_t$. Engel (1995:25) notes that "in any decomposition, the puzzling issue is how to deal with comovements." Still, considering the comovements between $\Delta_n x_t$ and $\Delta_n y_t$, that is, not simply assuming these to equal zero is important. If they account for a great fraction of real exchange rate variation, the fraction of real exchange rate variation contributed to $\Delta_n x_t$ depends crucially on how the comovements are treated. Therefore, I follow Mendoza (2000) and present three variance ratio measures, each of which treats the covariance differently.

The first measure assumes a zero covariance between $\Delta_n x_t$ and $\Delta_n y_t$, which is correct only when x and y are independent random walks:

$$\textit{Variance Ratio 1} = \frac{var(\Delta_n x_t)}{var(\Delta_n x_t) + var(\Delta_n y_t)}$$

The value of this variance ratio is, by definition, always below 1. It is proposed by Engel (2000) in his analysis of Mexican real exchange rates, and neglects the covariance between $\Delta_n x_t$ and $\Delta_n y_t$. Engel justifies this with his finding that the covariance is very small in industrial countries.[5] Mendoza (2000), in contrast, finds a negative correlation between $\Delta_n x_t$ and $\Delta_n y_t$ during fixed and managed exchange rate regimes in Mexico, and therefore proposes two alternative variance ratios. One measure contains the covariance of $\Delta_n x_t$ and $\Delta_n y_t$ only in the denominator, that is, assigns the entire comovements to y_t :

$$\textit{Variance Ratio 2} = \frac{var(\Delta_n x_t)}{var(\Delta_n q_t)} = \frac{var(\Delta_n x_t)}{var(\Delta_n x) + var(\Delta_n y) + 2cov\left(\Delta_n x, \Delta_n y\right)}$$

Another measure attributes half of the covariance to x_t :

$$\textit{Variance Ratio 3} = \frac{var(\Delta_n x_t) + cov(\Delta_n x_t, \Delta_n y_t)}{var(\Delta_n q_t)}.$$

[5]Similarly, the ratios of Mean Squared Errors reported in Engel (1999) were also constructed under the assumption of a zero covariance between $\Delta_n x$ and $\Delta_n y$.

Ceteris paribus, a negative covariance between $\Delta_n x_t$ and $\Delta_n y_t$ increases the value of Variance Ratio 2 relative to Variance Ratios 1 and 3.[6]

Varying n allows to differentiate between short and medium run determinants of real exchange rates. On the basis of PPP, one would expect the share of the variance accounted for by the x component to diminish over time: If deviations from PPP are transitory, only short run real exchange rate fluctuations should be determined by nominal exchange rate movements. It should be pointed out, however, that parts of the literature have been reluctant to interpret fluctuations in x as deviations from the law of one price. Mendoza (2000:12), for example, states:

> "The evidence reported here (...) does not suggest per se that one should view fluctuations in x as deviations from the law of one price or evidence of price stickiness. It simply shows how much x contributes to explain the variance of exchange-rate-adjusted CPIs. This is distant from the ideal scenario needed to interpret changes in x as deviations from the law of one price."

The 'ideal scenario' requires the conditions for PPP to hold, that is, homogenous goods which are traded on perfect international markets, identical baskets of traded goods across countries and instant price adjustment. Despite the fact that these assumptions are violated by the data, this chapter interprets fluctuations of x as failures of PPP *as incorporated in macroeconomic models on ERBS*. As pointed out in section 1.5, most of these models assume instant equality of aggregate cross-country traded goods' price indices despite the above-mentioned caveats.

Finally, it should be noted that decomposing the aggregate price level into tradables' and non-tradables' prices (equations 2.2 and 2.3) assumes that all goods can be unambiguously classified as either purely tradable or non-tradable; a task whose difficulty gave rise to recent research on the degree of tradability of goods (Betts and Kehoe, 2001) and on the distribution costs of tradable goods (Burnside, Neves and Rebelo, 2000).

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[6] The connection between measures 2 and 3 is given by *Variance Ratio 3*=*Variance Ratio 2*+$\frac{cov(\Delta_n x_t, \Delta_n y_t)}{var(\Delta_n q_t)}$.

2.4 Variance Decompositions of the Brazilian-US Real Exchange Rate

2.4.1 Data Transformation

The first step in the decomposition of real exchange rate movements is constructing price indices for tradable and non-tradable goods. The indices considered in this chapter are based on monthly observations of disaggregated consumer prices in Brazil and the US, dating from January 1981 to April 2001. The focus on consumer prices is dictated by data availability. Engel (1999) reports his results to be robust to modifications of the real exchange rate measure, that is, calculating it with other consumer or producer prices. This suggests that alternative measures for the Brazilian rate would yield similar results. Though the empirical equivalent to the real exchange rate measure used in macroeconomic modeling is the real effective exchange rate, focussing on the Brazilian-US real exchange rate is an admissible simplification, since 34.2 percent of Brazil's imports and 36 percent of its exports are either from or to the US or countries whose currency was pegged to the US dollar for most of my sample.[7]

Brazilian price indices are obtained from the *Instituto de Geographia e Informatica*; the US data from the *Bureau of Labor Statistics*.[8] The index of tradable goods' prices is constructed as a weighted average of the price indices for 'Residential Articles' and 'Clothing'; the price index for non-tradable goods from the price indices for 'Housing', 'Transport and Communication', 'Health and Personal Care', and 'Personal Expenses'. The price index for 'Food and Beverages', which are frequently classified as tradable goods (see for example Chari et al., 1998), is excluded, since non-tradable 'Food Away From Home' enters the US data with a weight of 37 percent; the correlation coefficient between the price indices for 'Food and Beverages' and 'Services' is almost unity. In all other respects, the classification of traded and non-tradable goods follows the literature as summarized in appendix 2.6.1, and is consistent with Betts and Kehoes' (2001) trade-based classification.[9] It should be noted that indices for tradable and non-tradable goods are never perfect. The category 'Housing', for example, includes tradable 'Fuels and Utilities', whereas prices for 'Residential Articles' in Brazil have recently in-

[7] These numbers are based on data for the year 2000, in which exports to the US and Argentina amounted to 23.1 and 11.1 percent, respectively, and imports from these countries to 23.8 and 12.2 percent.

[8] See appendix 2.6.2 for a detailed description of data sources and transformations.

[9] A trade-based classification of tradable and non-tradable Brazilian goods is precluded by lacking data on foreign trade flows for the groups of goods entering the Brazilian CPI.

cluded the cost of their maintenance and repair. These sub-categories could not be considered separately, as the more detailed classification of Brazilian prices is available only from 1991 onwards.

The overall weight of non-tradable goods in the CPI is computed as the sum of the most recent weights of 'Food & Beverages Away From Home', 'Shelter', 'Transportation', 'Communication', 'Medical Care Services', 'Miscellaneous Personal Services', 'Recreation' and 'Education'. This yields a share of 71 percent for non-tradables in the US CPI and of 46 percent in the Brazilian CPI.[10] Based on these weights, the price indices for traded and non-tradable goods and the US-Brazilian nominal exchange rate, x, y, and q are computed.

2.4.2 Decomposition Results

As pointed out, results by Mendoza (2000) indicate considerable differences between the determinants of real exchange rate fluctuations during periods of fixed and of flexible exchange rates. Therefore, variance decompositions were performed with three different samples: First, with the full sample from January 1981 to April 2001. Second, for periods of officially fixed or managed exchange rates, and third, for periods of 'relatively stable exchange rates', which are quantified as periods where the monthly devaluation rate remains below ten percent for at least six consecutive months. This holds for the periods from February 1981 to January 1983, from March 1986 to January 1987, from August 1994 to December 1998, and from March 1999 to February 2001, that is, for a total of 112 months. During 74 of these, a regime of fixed or managed exchange rates was implemented; namely, the 'Cruzado Plan' from March to October 1986, which maintained a zero devaluation rate most of the time, and the 'Plano Real' from July 1994 to December 1999. It entailed the introduction of a new currency – the 'Real' – which was initially pegged to the US dollar at parity. In March 1995, a one-time 5-percent devaluation was administered, and a 5-percent fluctuation band introduced. The stabilization effort collapsed in January 1999, giving rise to a monthly devaluation rate of 25 percent.[11]

[10] Proceeding this way, it is implicitly assumed that prices which were omitted (like the prices of Food and Beverages) and those which could not be assigned to the appropriate group of goods because of lacking data (as for example the fuel prices contained in 'Shelter') behave like the *average* tradables' and non-tradables' prices I compute. An alternative approach is to calculate γ and γ^* considering only the weights of prices which actually enter the price indices of traded and non-traded goods. The variance decompositions based on these values yield very similar results, and are therefore not reported, but available upon request.

[11] See Bonomo and Terra (1999) for further details on exchange rate policy in Brazil.

No. of obs.	Full Sample *243*		Official. fixed *61*		Devr.<10% *112*	
	Mean	Std	Mean	Std	Mean	Std
q	4.15	0.30	3.87	0.20	4.04	0.24
x	4.3	0.29	4.25	0.1	4.33	0.26
y	-0.14	0.20	-0.29	0.18	-0.23	0.21

Notes: 'Devr.<10%' denotes the sample which contains only months where the monthly devaluation rate was below 10% for at least six consecutive months; 'Official. fixed' denotes periods of officially announced managed exchange rate regimes. x, y and q are in levels, that is, n=0.

Table 2.1: Characteristics of x, y and q during different exchange rate regimes

Characteristics of x, y and q (in levels) during the different samples are summarized in table 2.1. It confirms that the real exchange rate appreciates during periods of officially fixed or stable exchange rates – the mean of q is lower during these periods, that is, domestic goods relatively more expensive. Furthermore, the real exchange rate fluctuates less during these periods. Given the high share of non-tradables in the US CPI, the fact that y assumes a negative value indicates that the ratio of non-tradables' to tradables' prices in Brazil is higher than the ratio of these prices in the US, that is, relative non-tradables' prices in Brazil exceed those in the US.[12] y seems to be positively correlated with the devaluation rate, which suggests that Brazilian relative non-tradables' prices rise during these periods of relatively low devaluation rates. This will be confirmed by the analysis of variance ratios.

The first set of variance ratios is computed for the full sample from January 1981 to April 2001. Figure 2.1 graphs the three variance ratio measures. The ordinate reports the value of the real exchange rate ratio for a specific horizon, that is, a specific value of n (in months), which is reported on the abscissa. The variance ratio for $n = 24$, for instance, indicates how much of the variance of the real exchange rate's change over the past two years is due to the variance of the change in cross-country tradables' prices.

Figure 2.1 shows that the value of Variance Ratio 1 remains at around 0.90 regardless of the horizon considered. Even for two-year differences, 91

[12]This can be shown as follows: y is defined as

$$y \equiv [\gamma^*(p_N^* - p_T^*) - \gamma(p_N - p_T)] .$$

The share of non-tradable goods in the Brazilian GDP is smaller than in the US, $\gamma < \gamma^*$. Thus, a negative y implies that $(p_N - p_T) > (p_N^* - p_T^*)$.

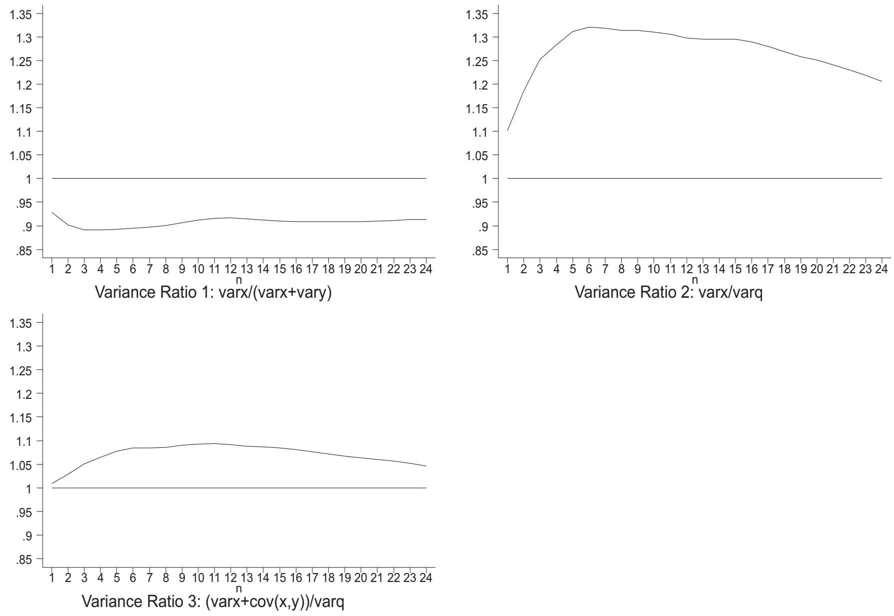

Figure 2.1: Variance decompositions over the full sample

percent of the real exchange rate changes' variance is due to the variation of $x_t - x_{t-24}$. The maximum value of 0.93 occurs for one-month differenced data $(n = 1)$. These values are slightly lower than what Engel (1999) found for US-European real exchange rates[13] – but still a death blow for PPP. Moreover, the importance of cross-country tradables' prices does not diminish when considering longer horizons: Figure 2.2 reports variance decompositions for differences of up to 210 months. Even at these long horizons, the contribution of cross-country tradables' prices to total real exchange rate variation, as measured by Variance Ratio 1, exceeds 80 percent.[14]

Variance Ratios 2 and 3 in figures 2.1 and 2.2 exceed unity for most values of n. This is at odds with the interpretation of variance ratio as denoting the fraction of real exchange rate variation due to variation in cross-country tradable goods: No component can sensibly account for *more* than total real exchange rate variation. This demonstrates that the fraction of the covariance assigned to $\Delta_n x_t$ is to some extent arbitrary, as al-

[13] The variance ratios for US-Italian and US-German real exchange rates, for example, always exceed 95% for horizons of up to 400 months (Engel, 1999:513).

[14] The minimum of 0.82 is reached for $n = 185$. It should be noted, however, that the variance ratio statistic is not very reliable at long horizons, where only few observations enter the calculation. This loss of statistical significance is a plausible explanation for the variance ratio's increase for $n > 93$, and the pronounced rise for $n > 185$.

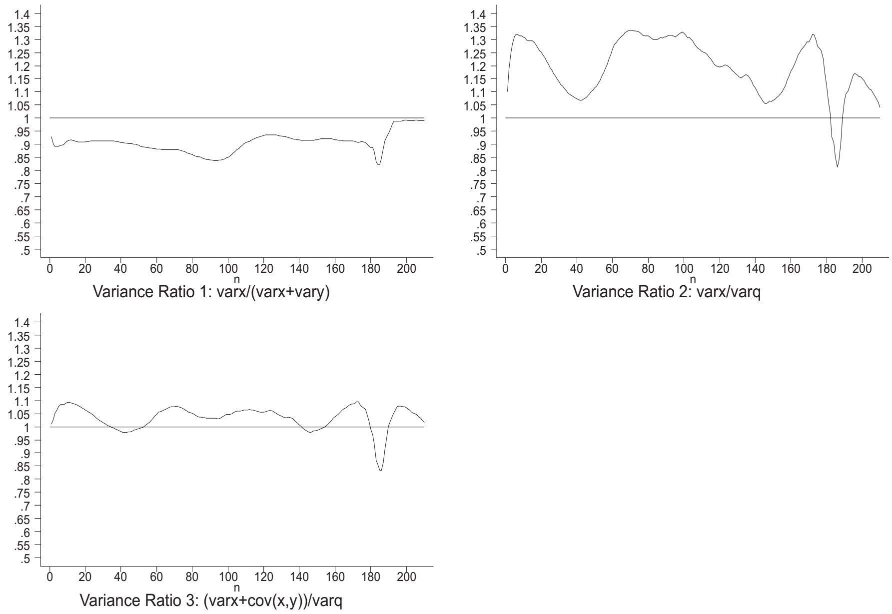

Figure 2.2: Variance decompositions over the full sample with a maximum difference of 210 months

ready pointed out in section 2.3. Variance ratio values exceeding unity result from the negative covariance of $\Delta_n x_t$ and $\Delta_n y_t$: Variance Ratio 2 is greater than one when $[0.5var(\Delta_n y_t) < -cov(\Delta_n x_t, \Delta_n y_t)]$; Variance Ratio 3 when $[var(\Delta_n y_t) < -cov(\Delta_n x_t, \Delta_n y_t)]$. How can the negative correlation between $var(\Delta_n y_t)$ and $cov(\Delta_n x_t, \Delta_n y_t)$ be interpreted? Given that $\Delta_n x_t$ is mainly determined by nominal exchange rate fluctuations, my interpretation of the negative correlation is that an increase in nominal exchange rate fluctuations is associated with increased volatility of the relative price of domestic non-tradable goods. This can be shown as follows: $\Delta_n x$ is given as

$$\Delta_n x \equiv \Delta_n e + \Delta_n p_T^* - \Delta_n p_T$$

and $\Delta_n y$ as

$$\Delta_n y \equiv [\gamma^* \Delta_n (p_N^* - p_T^*) - \gamma \Delta_n (p_N - p_T)] \, .$$

The negative covariance implies that increases in $\Delta_n x$ are accompanied by a reduction in $\Delta_n y$. The latter occurs when $\Delta_n(p_N - p_T)$ increases. This finding is compatible with the empirical literature on the effects of inflation on relative price volatility: Tommasini (1993) and Lach and Tsiddon (1993) report that the volatility of relative prices increased during inflationary periods in Argentina and Israel.

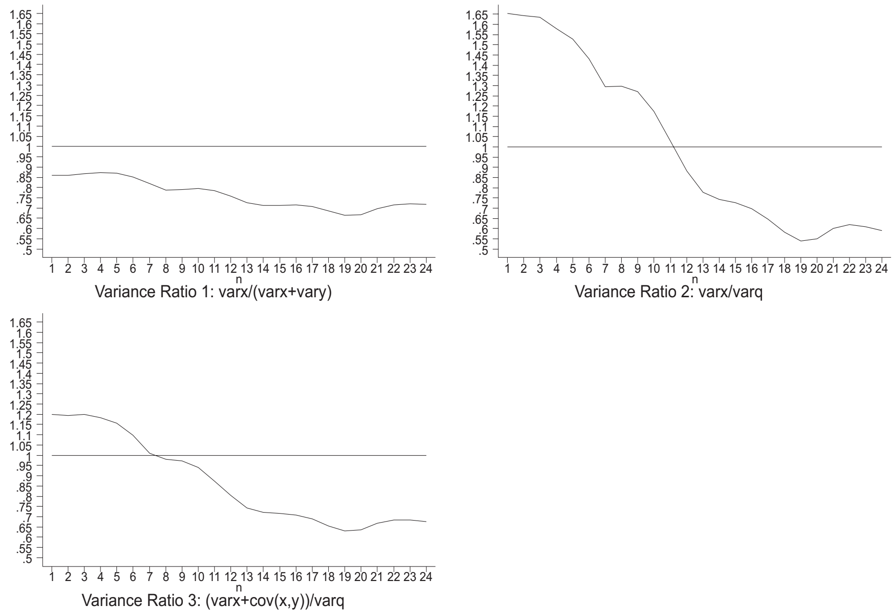

Figure 2.3: Variance decompositions: only periods of fixed or managed exchange rates

Given the evidence presented in figure 2.1, Engel's (1999:507) statement that "relative prices of non-tradable goods appear to account for almost none of the movement of US real exchange rates" seems to be confirmed by the Brazilian-US real exchange rate. This result is disproved, however, when focusing on periods of *managed* exchange rates[15] (see figure 2.3): During these, relative non-tradables' prices explain almost half of total real exchange rate variation – the minimum values of Variance Ratios 1 to 3 are 0.66, 0.54 and 0.63, respectively. Furthermore, the share of real exchange rate movements due to cross-country tradables' prices decreases for longer horizons, as to be expected if deviations from PPP are transitory.

As shown by figure 2.4, the same holds true for periods with a monthly devaluation rate below 10 percent: The minimum values of Variance Ratios 1, 2 and 3 equal 0.55, 0.46 and 0.56, respectively. These findings indicate that the causes of real exchange rate fluctuations vary with the exchange rate regime under consideration and over the time horizon: For the full sample, which includes both regimes of fixed and of floating exchange rates, relative non-tradables' prices are of minor importance for real exchange rate fluctuations. During periods of managed exchange rate regimes and low devaluation

[15]These are defined to include periods of fixed exchange rates.

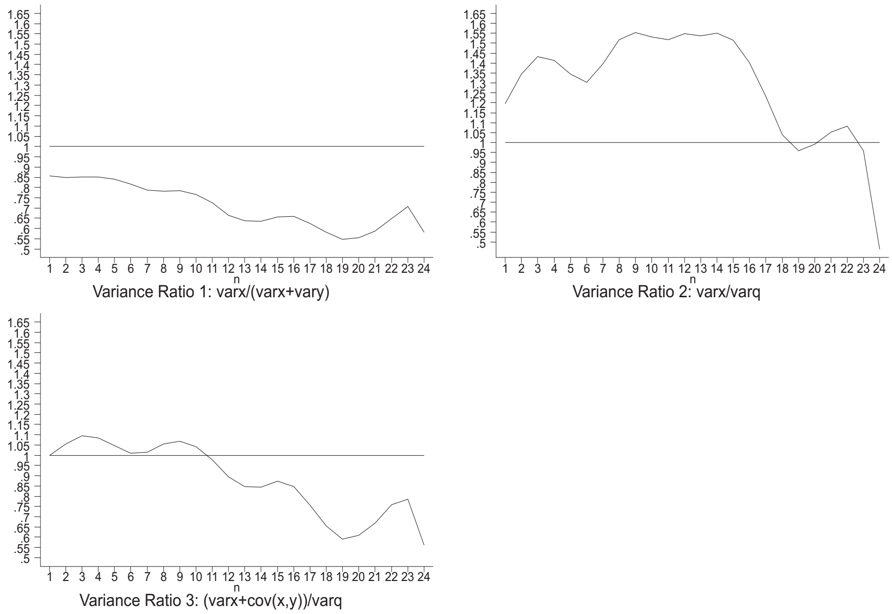

Figure 2.4: Variance decompositions: only periods with a monthly devaluation rate below 10%

rates, in contrast, they account for up to half of the real exchange rate's variance. Furthermore, the contribution of cross-country tradables' prices to real exchange rate fluctuations is decreasing over time for the low-devaluation subsample, as suggested by PPP.

How can these differences across exchange rate regimes be explained? A straightforward justification is based on regime-specific nominal exchange rate volatility coupled with sticky prices: As reported in table 2.1, fluctuations of the Brazilian-US nominal exchange rate are considerably higher during periods of flexible exchange rates which, ceteris paribus, increases the contribution of $var\,(\Delta_n x)$ to real exchange rate movements. In this context, the 'ceteris paribus' assumes constant domestic-currency prices of foreign and home goods, which implies that the covariance between $\Delta_n x$ and $\Delta_n y$ is zero, and that PPP fails. The former is valid at longer horizons for periods of fixed exchange rates. In the short run and for the full sample, however, $\Delta_n x$ and $\Delta_n y$ exhibit a negative covariance.[16] This suggests that it is negatively related to the nominal exchange rate's variance $\left(\frac{\partial cov(\Delta_n x, \Delta_n y)}{\partial var(\Delta_n e)} < 0\right)$. When this is considered, the effect of an increase in $var(\Delta_n e)$ on Variance Ratios 2 and 3 becomes ambiguous.

[16] Of an absolute magnitude of about one third of the variance of $\Delta_n q$.

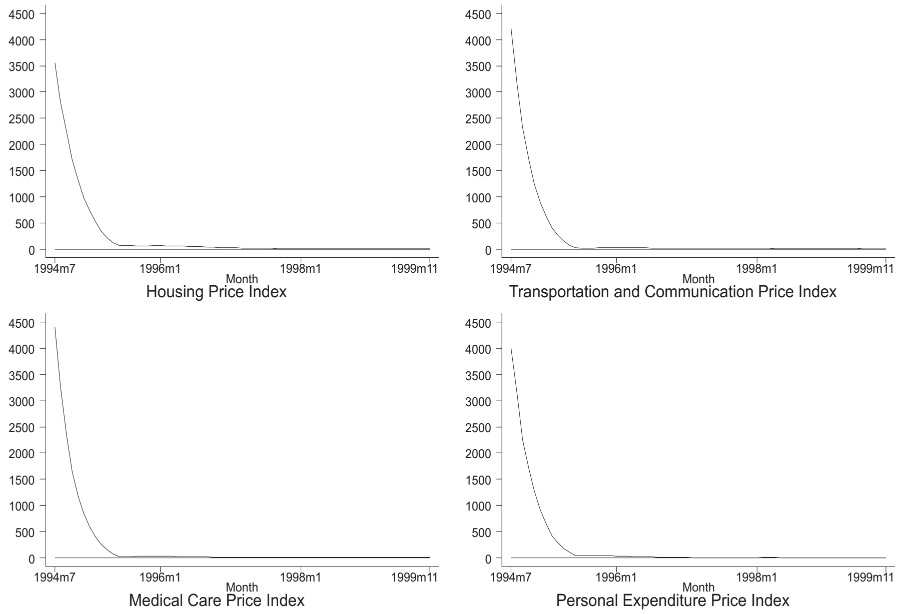

Figure 2.5: Annual growth rates of non-tradables' prices during the 'Real' stabilization (in %)

Another explanation is offered by the models discussed in Chapter 1.

These show that cash-covered transactions will rise as ERBS induces a fall in inflation rates. Coupled with temporarily inelastic supply of non-tradable goods, the positive demand shock produces an initial increase in relative non-tradable goods' prices, which subsides when supply increases. This increases the volatility of non-tradables' prices and their contribution to the real exchange rate volatility. As an informal exploration of this hypothesis, annual and monthly growth rates of various non-tradables' prices during the 1994 'Real' stabilization are graphed in figures 2.5 and 2.6. Figure 2.5 shows that ERBS is initially accompanied by high growth rates of non-tradables' prices, which are gradually reduced as a result of the exchange rate peg. All non-tradables' prices are characterized by large fluctuations, as figure 2.6 evinces.

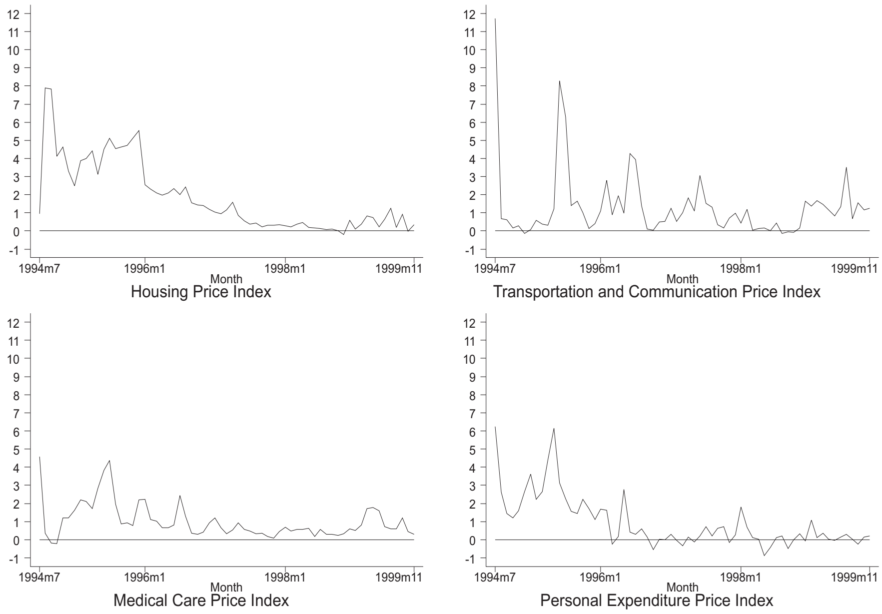

Figure 2.6: Monthly growth rates of non-tradables' prices during the 'Real' stabilization (in %)

2.5 Conclusions

This chapter presents decompositions of Brazilian-US real exchange rate fluctuations from April 1981 to May 2001. For the full sample, movements of the relative price of non-tradable goods are found to account for less than 20 percent of the real exchange rate's variance. When focusing on periods of managed or relatively stable exchange rates, however, the contribution of relative non-tradables' prices reaches up to 50 percent. The difference across exchange rate regimes confirms Mendoza's (2000) findings based on Mexican-US real exchange rates. Thus, the relatively high contribution of non-tradables to real exchange rate fluctuations apparently constitutes an additional 'stylized fact' of ERBS.

My findings underline differences between real exchange rate behavior in developing and industrial economies: First, the determinants of real exchange rate fluctuations in industrialized countries do not change across exchange rate regimes. Second, the difference between the real exchange rate's variance during regimes of fixed and of flexible exchange rates is much higher in industrial countries: Mussa (1986) reports a tenfold rise in the real exchange rates' variance during periods of floating exchange rates. For the Brazilian-US real exchange rate, I find a less than twofold increase. These differences point to particularities in the price setting processes of industrial and developing countries, a topic which has been little researched so far.

Models on the real effects of ERBS typically assume PPP to hold and attribute all real exchange rate movements to changes in relative non-tradables' prices. This is only partially confirmed by my empirical analysis: Even during fixed exchange rate regimes and horizons of up to two years, more than half of the real exchange rate movements are due to differences in exchange rate-adjusted prices of tradable goods. This raises the question of whether the models incorporating PPP miss a crucial aspect of price setting in developing countries. In my opinion, the answer is negative: Replacing PPP by a weaker, but still *positive* relationship between domestic and foreign tradables' prices – as indicated by the data – would not alter the models' qualitative results. Substituting PPP in calibrated models of ERBS, however, could prove to be fruitful – in particular since Rebelo and Végh (1995) show that the magnitude of the real exchange rate appreciation cannot be reproduced in flexible-price models in which PPP holds.[17] The exact formulation to replace PPP is still subject to debate. The analysis undertaken in this chapter is one of accounting, and can provide only frail indications on what should replace PPP: One is the reduced synchronization between nominal exchange rates and tradable goods' prices during periods of high (and volatile) devaluation rates. This could possibly result from the existence of fixed menu costs associated with changing tradables' prices. Further investigation into the nature of price setting in high inflation countries could shed light on this conjecture.

As for now, I retain the finding that fluctuations of relative non-tradables' prices *do* contribute to real exchange rate fluctuations. In a next step, presented in the following chapter, possible determinants of relative non-tradables' prices are assessed.

[17]Another shortcoming of calibrated models is their failure to reproduce the observed *persistence* of real exchange rate fluctuations, see for example Chari et al. (1998). This subject is not addressed here since my empirical analysis is based on real exchange rate *changes*, and hence not ideally suited for an assessment of real exchange rate persistence.

2.6 Appendix

2.6.1 Summary of the Literature on Real Exchange Rate Decompositions

Publication	Geographical Coverage	Traded Goods	Non-Traded Goods	Period	Data Source
Chari, Kehoe, McGrattan 1998 Measure I	USA, Europe	CPI: Food, all goods less food	CPI: Rent, services less rent	1972-1994	OECD MEI
Measure II	USA, Europe (France, Italy, UK)	Private consumption deflators: Durables, semi-durables and non-durables	Private consumption deflators: Services	1972-1994	OECD Quart. Nat. Acc.
Measure III	USA, Europe	Wholesale prices		1972-1994	
Engel 1999 Section I	Canada, France, Germany, Italy, Japan, US	CPI: Food, all goods less food	CPI: Shelter, all services less shelter	1/1962 - 12/1995	OECD MEI
Section IV	Japan, USA, Europe	Overall producer price index	Consumer price index	1.1972 - 1997	OECD MEI

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Publication	Geographical Coverage	Traded Goods	Non-Traded Goods	Period	Data Source
Engel 2000 Measure I	Mexico, USA	Mex.: Consumer prices of traded goods; US: Consumer prices of commodities	none	9.1991-8.1999	Datastream
Engel 2000 Measure II		Consumer prices of traded goods: food, household furnishings, apparel	none		
Mendoza 2000	Mexico, USA	CPI: Durables, non-durables	CPI: Services	1.1969-5.2000	BoM, BLS
Parsley 2001	6 Asian Countries, USA	Different consumer price indices	Different consumer price indices	1990 - 2000	
Burnstein, Neves, Rebelo 2000	Argentina, USA	Various consumer prices	Various consumer prices	4.1991 - 4.1993	Argent. Ministry of Econ.

Notes: "OECD MEI" denotes the OECD's Main Economic Indicators, "BoM" the Bank of Mexico and "BLS" the Bureau of Labor Statistics.

Result of all above-mentioned studies, with exception of Mendoza (2000): Most of real exchange rate appreciation due to cross country tradable goods' prices.

2.6.2 Data

Brazilian prices are based on the national consumer price index (*Indice Nacional de Preços ao Consumidor, INPC*), which reports the sub-categories 'Food and Beverages', 'Housing', 'Apparel', 'Transportation and Communication', 'Medical Care' and 'Personal Expenditure'. From August 1999 onwards, prices for 'Transportation' and Communication' are reported separately. The 'Transportation and Communication' index is constructed by weighting the variables with their respective weights in the CPI, that is 14.37 percent for 'Transportation' and 1.05 percent for 'Communication'. Likewise, the price of 'Education' is excluded from 'Personal Expenditure' from August 1999 onwards. I reconstruct the previously used index by including the price index for 'Education' with a weight of 0.26. All data on Brazilian prices was obtained from the *Instituto Brasileiro de Geographia e Estatística* (*www.ibge.gov.br*).

US Consumer Prices for 'All Urban Consumers' were obtained from the *Bureau of Labor Statistics* (*www.bls.org*). A price index equivalent to the Brazilian index of 'Personal Expenses' is calculated from the price indices for 'Entertainment/Recreation' (until December 1992) and 'Miscellaneous Personal Services'. Instead of 'Transportation and Communication', only 'Transportation' was used until December 1992.

The nominal exchange rate from January 1981 to May 2000 was obtained from the International Financial Statistics (market rate, US dollars per real, period average, Line *ah*). Thereafter, the monthly arithmetic average calculated from the daily exchange rate (*Taxa Venta*), as reported by the Brazilian Central Bank, (*www.bcb.br.gov*) is used.

All prices and the exchange rate are re-based such that the arithmetic average from January 1982 to December 1984 equals 100. Prices are not seasonally adjusted.

The overall weight of non-tradable goods' prices in the CPI is computed as the sum of the weights of 'Food & Beverages Away From Home', 'Shelter', 'Transportation', 'Communication', 'Medical Care Services', 'Miscellaneous Personal Services', 'Recreation' and 'Education'. Weights entering the Brazilian CPI are based on the 1987/88 *Pesquisa de Orçamentos Familiares.* They were used for calculating the CPI from June 1989 to July 1999. Previously, the weights were based on the *Pesquisa ENDEF* of 1974/75, and beginning in August 1999, on the 1995/96 *Pesquisa de Orçamentos Familiares.* US weights are based on the 1993-95 Household Survey. These have been used for calculating the CPI since January 1998.

Chapter 3

Forward-Looking Price Setting during Temporary Exchange Rate-Based Stabilizations

3.1 Motivation

Exchange rate pegs in high inflation economies are typically accompanied by pronounced real exchange rate movements. This has been documented by two strands of empirical research: First, studies on the stylized facts of ERBS, which found the *implementation* of – frequently transitory – exchange rate pegs in high inflation economies to be accompanied by a pronounced real exchange rate appreciation. Second, the literature on early warning indicators for currency crises, which documents that the *collapse* of exchange rate pegs is generally preceded by a real exchange rate appreciation. The empirical analysis of the stylized facts of (temporary) ERBS conducted in section 1.3.2 revealed that the real appreciation is halted only when the stabilization is abandoned and followed by a nominal depreciation. Furthermore, the gradual real appreciation was found to be accompanied by a consumption boom. Argentina's 'Tablita' Program, a crawling peg implemented in December 1978 and abandoned in the first quarter of 1981, illustrates this phenomenon. Figure 3.1 evinces that the Argentinean devaluation rate reduction was paralleled by a real exchange rate appreciation which was halted only with the peg's end in 1981.

Empirical studies on early warning indicators for currency crises in semi-industrialized economies suggest that these are typically preceded by real exchange rate appreciations, regardless of the peg's previous duration. Klein and Marion (1997), for example, identify determinants of the duration of cur-

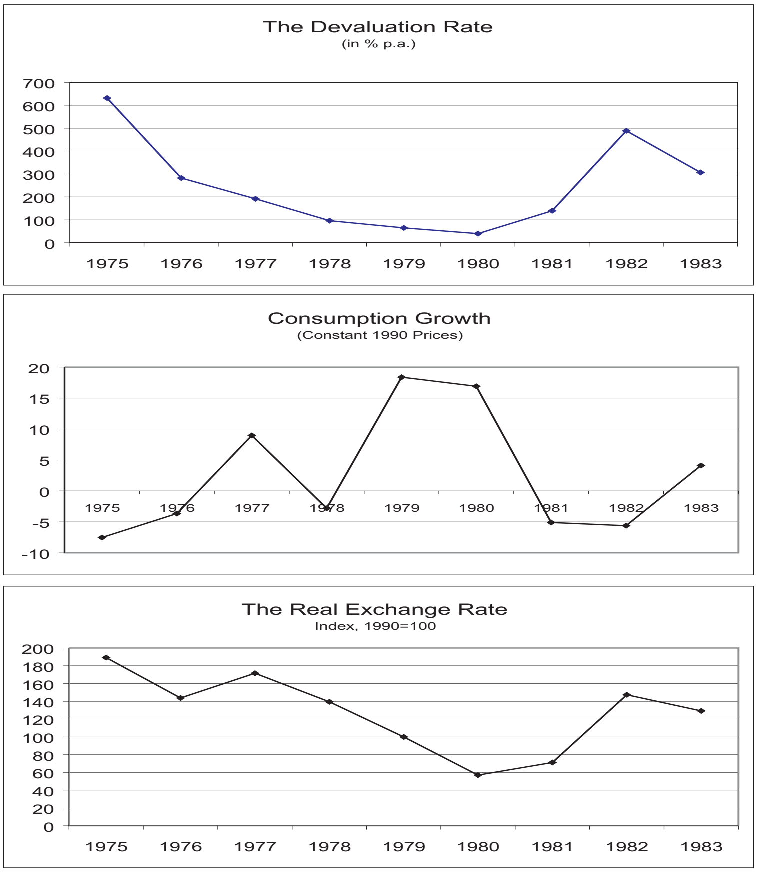

Figure 3.1: Consumption and real exchange rate dynamics during the Argentinean 'Tablita' stabilization program

rency pegs. Based on data for a panel of 17 countries over the period from 1957 to 1991, they find devaluations to be predated by sharp real appreciations. Similarly, Kaminsky, Lizondo and Reinhart (1998) survey the empirical literature on early warning indicators for developing countries' currency crises, and identify the real exchange rate appreciation as a key predictor.[1] This result is supported by other empirical studies on developing economies by Frankel and Rose (1996), Kamin and Babson (1999) , as well as Kaminsky and Reinhart (1999).[2]

How can the pre-crisis real exchange rate appreciation be rationalized? The *literature on currency crises* has largely failed to offer an explanation. Without explicit reference to a modeling framework, it tends to view the real appreciation as a 'fundamental' phenomenon. Kamin and Babson (1999:7), for instance, classify the real exchange rate as a variable "reflecting the fundamental determinants of a country's financial position", in contrast to "variables reflecting market expectations of a future crisis or the initial effects of an emerging crisis". This stands in contrast to the notion of forward-looking nominal exchange rates, which, coupled with sticky domestic and foreign prices, produce forward-looking real exchange rates.

As pointed out in Chapter 1, the recent *literature on the stylized facts of ERBS* regards the real appreciation as the result of excess demand for non-tradable goods, coupled with sluggish adjustment of non-tradables' supply. However, simulations show that the magnitude of the real appreciation arising from the above mechanism falls significantly short of the empirical observed ones (Rebelo and Végh, 1995). Extensions by Uribe (1997b) and Burnstein, Neves and Rebelo (2000) improve the models' quantitative performance in reproducing the real appreciation: In general equilibrium models with flexible prices, Uribe assumes habit formation, whereas Burnstein et al. relax the assumption of purchasing power parity for tradable final goods by introducing a distribution sector. Despite these extensions, the real appreciation still hinges on the assumption of excess demand for and deficient supply of non-tradable goods. However, some evidence suggests that this might not be the only source of the real exchange rate appreciation: Section 1.3.2 indicates an increase in inventories before and during stabilizations, which contradicts the notion of supply shortages. Furthermore, sketchy data on car sales in Latin

[1] Kaminsky et al. (1998) list a total of sixty explanatory variables which have been included in regressions explaining currency crises. Only six variables of those have been included in at least four of the surveyed publications and have proved to be significant in at least half of the estimations. These six variables are the real exchange rate, international reserves, credit growth, inflation, real GDP growth or level, and the fiscal deficit.

[2] Similarly, Eichengreeen, Rose and Wyplosz (1995) find that *OECD countries* experience problems of external balance prior to devaluation crises.

America suggests that the consumption boom during ERBS mainly reflects increases in tradable goods purchases.[3]Moreover, excess demand is a very unlikely cause for the real appreciation witnessed before currency crises in developing economies, as these are typically preceded by below-trend output (see Kaminsky et al. 1998).

An alternative explanation for the initial real appreciation during ERBS is offered by the 'early' reduced-form models. Rodriguez (1982) and Dornbusch (1982) explain the stylized facts and termination of ERBS, respectively, in models with inflation inertia. In these models, backward-looking inflation expectations or predetermined inflation rates give rise to a slow adjustment of prices to the (stabilized) devaluation rate, producing the real appreciation. More recently, Calvo and Végh (1993) incorporate sluggish adjustment of non-tradables' prices in an optimization-based model of temporary stabilization.[4] However, despite this extension, the cause of the real appreciation is identical to what is underlying the flexible-price models discussed above: Stabilization effects an increase in goods demand, causing the price of non-tradable goods to rise and the real exchange rate to appreciate.

The model presented in this chapter shares two properties of Calvo and Végh's framework, namely the existence of price stickiness and the perfectly anticipated temporariness of stabilization. These features give rise to a new mechanism for real exchange rate appreciation: Non-tradable producers' price setting behavior. This is explored in a small open economy, in which producers of intermediate non-tradable goods are monopolists which can change their prices only every other period. The price of tradable goods, in contrast, is determined by PPP. Stabilization is defined as a publicly known, temporary fall in the nominal exchange rate. Given PPP, this is equivalent to a reduction in tradable goods' prices. This effects a decrease in nominal unit input costs of the production of non-tradable goods. However, as producers of non-tradable goods anticipate the future devaluation rate increase, and incorporate this expected rise in input costs in current prices, the relative price of non-tradable goods exceeds its pre-stabilization value, and the real exchange rate appreciates. Thus, the transitoriness of stabilization affects the real exchange rate through two channels: First, as in other models, via the increase in demand and second, via the forward-looking pricing of non-tradable goods. In contrast to models which rely exclusively on the first channel, the second channel can also explain the real appreciation witnessed in the eve of

[3]Data on car sales is analyzed by de Gregorio et al. (1998) and Calvo and Végh (1999).

[4]Calvo and Végh assume that non-tradables' prices do not immediately reach their market-clearing level, but rise slowly if demand exceeds an exogenously given full employment output. This, however, is contradictory to their alleged assumption of demand-determined supply of non-tradables.

currency crises.[5]

Technically, the model is closest to frameworks with monopolistic competition and sticky prices by Kiley (2002) and Obstfeld and Rogoff (1996, Chapter 10). The latter is part of the recent research on open economies with sticky prices, which includes approaches by Svensson and van Wijnbergen (1989), Obstfeld and Rogoff (1995), Corsetti and Pesenti (1997), and others surveyed by Lane (2001). The three aforementioned models present economies with forward-looking, optimizing agents in an environment with short run nominal price rigidities, but in which the law of one price holds for traded goods.[6] The model here follows this literature and introduces price stickiness by assuming that producers of non-tradable goods fix their prices in the period prior to an exogenous shock (which, in my model, is the nominal devaluation). This, of course, is to some extent arbitrary. Alternatively, the forward-looking price setting could be based on microeconomic foundations by introducing convex price adjustment costs.[7] This would yield similar qualitative results as the imposed two-period price setting: Adjusting the price of non-tradable goods to the decrease and the subsequent surge of tradables' prices is then associated with costs which increase in the price change's magnitude. Thus, price setters find it optimal to decrease non-tradables' prices by less than implied by the fall in input prices, incorporating the future increase. However, extending the model in this direction would render the derivation and interpretation of implied real exchange rate movements much more tedious – as noted by Obstfeld and Rogoff (1996:674):

> "It is profoundly difficult to rationalize nominal price rigidities in a way that is both theoretically elegant and empirically sensible."

My modeling choice was initially skewed towards greater analytical simplicity. An extension of the original model presented in section 3.3 shows that the main results remain valid when assuming overlapping price contracts à la Taylor (1979, 1980).

A crucial element of the model is that agents anticipate the peg's collapse, that is, the deficient credibility of stabilization. This lack of credibility is a

[5] It should be noted that the implied *positive* impact of expected currency devaluation on relative non-tradables' prices is opposite to what models of strategic price setting derive as optimal exchange rate pass through (see for example Tirole, 1988, and Froot and Klemperer, 1989). This does not undermine my model, as it is perfectly sensible that price setting processes should vary under different circumstances, that is, between low inflation industrialized economies and high inflation developing countries.

[6] However, most of above-mentioned work deals with two symmetric economies, which is not adequate for my analysis of small high inflation economies.

[7] Convex price adjustment costs have for example been used in models by Rotemberg (1987) and Caballero (1989) .

likely fate of inflation stabilization efforts in chronic inflation countries, where a prolonged fight against inflation and a large number of unsuccessful stabilization programs are likely to render any additional stabilization effort ex ante non-credible. Empirical evidence on the deficient credibility of stabilizations in developing economies has been presented, among others, by Baxter (1985), Agenòr and M. Taylor (1993), Ruge-Murcia (1995), and Agenòr and Masson (1999).

Another important feature of the model is, of course, the assumption of price stickiness. Evidence on goods pricing and the nature of nominal price rigidities in inflationary economies has been presented in section 1.6. An explicit account of *forward-looking* price setting prior to the recent crisis in Argentina is given by the *Economist* (2002, January 5th-11th:39), which reports that "some retailers have started putting up prices in anticipation of a devaluation." Similarly, Bruno and Piterman (1988) describe forward-looking wage setting during the Israeli stabilization experience:

> "[F]irms and workers apparently did not expect stabilization to last. Both firms and workers expected devaluation and a renewal of the inflation and therefore they set nominal wage increases at an excessively high level. It could reasonably be assumed, on the basis of more than a decade of experience on this regard, that the government could not be able to resist for long the pressure (...) for devaluation."

Under monopolistic competition, these wage increases are passed on to prices – giving rise to exactly the price setting hypothesis incorporated in this chapter's model.[8]

The remainder of this chapter is organized as follows: Section 3.2 presents a model with monopolistic competition and sticky non-tradables' prices and analyzes the effect of an exogenous, temporary fall in the exchange rate on consumption, the real exchange rate and the current account. Section 3.3 extends the model to incorporate staggered price setting. Section 3.4 empirically investigates the proposed price-setting mechanism, that is, the impact of devaluation expectations on non-tradables' prices, using disaggregated Mexican data. Section 3.5 discusses how the model could be extended to incorporate self-fulfilling currency crises.

[8] This can easily be shown in a modeling framework with sticky wages, as for example the one suggested by Obstfeld and Rogoff (1996) in their section 10.4.

3.2 The Model

The model economy is populated with agents that derive utility from the consumption of a basket of tradable and non-tradable goods, both of which are subject to a cash-in-advance constraint. Agents are endowed with a fixed amount of tradable goods, priced exogenously in the world market. Non-tradable final goods are produced competitively using a continuum of non-tradable inputs. Each agent owns a firm which holds a monopoly over producing one of these non-tradable intermediate goods. The firms which produce non-tradable intermediate goods maximize profits under the constraint that their goods' prices must remain constant for two periods. The non-tradable final good is produced with a continuum of differentiated intermediate goods. Home agents can borrow and lend abroad, whereas the expenditure of the home government is financed exclusively by issuing new currency. The model is deterministic and rational expectations hold, which implies that all agents have perfect foresight.

The next sections introduce the theoretical model. After deriving the agents' and the firms' optimal policies, monetary and fiscal authorities are considered. In a next step, the effects of a credible and a non-credible exchange rate peg are compared.

3.2.1 Consumption

A representative agent of the economy chooses his consumption path as to maximize the following utility criterion:

$$U_t = \sum_{s=t}^{\infty} \beta^{s-t} log(C_s) \tag{3.1}$$

To abstract from inessential dynamics, it is assumed that β, the subjective discount factor, equals the real interest rate factor, $(1+r)^{-1}$. C denotes a Cobb-Douglas consumption index over tradable (C_T) and non-tradable (C_N) consumer goods

$$C_t = C_{T,t}^{\gamma} C_{N,t}^{1-\gamma}. \tag{3.2}$$

$\gamma \in (0,1)$ and $(1-\gamma)$ are the weights of tradable and non-tradable goods.[9] Following Calvo and Végh (1993), it is assumed that consumption has to be covered with money holdings from the previous period:

$$P_{T,t}C_{T,t} + P_{N,t}C_{N,t} \leq M_{t-1} \tag{3.3}$$

[9]This formulation of the consumption basket implies a unity elasticity of substitution between tradables and non-tradables $\left(\frac{d\log\left(\frac{C_T}{C_N}\right)}{d\log\left(\frac{p_N}{p_T}\right)}|_{U=\bar{U}} = 1\right)$.

where M_{t-1} denotes period $t-1$ nominal money holdings and $P_{T,t}$ and $P_{N,t}$ the domestic currency prices of tradable and non-tradable final goods, respectively. The cash-in-advance constraint captures the function of money as a medium of exchange and can be thought to result from sequenced opening hours of goods and asset markets.[10] The above cash-in-advance constraint assumes that transactions in both the market for tradable and for non-tradable goods are conducted with *domestic* currency. An alternative formulation of the cash-in-advance constraint consists in requiring agents to hold either domestic or foreign currency for transacting, thus accounting for currency substitution (see Calvo and Végh, 1994b). However, this implies that the amount of seignorage accruing to the foreign central bank, and thus the economy's aggregate wealth, decreases in the inflation rate. In order to avoid these wealth effects, currency substitution is ruled out in this chapter's model.[11] Note that the cash-in-advance constraint holds with equality when the nominal interest rate is positive: Agents do not hold money in excess of what is strictly necessary for consuming if they can earn interest on holding bonds instead. Since attention is restricted to equilibria with positive interest rates, the cash-in-advance constraint therefore implies that

$$P_{T,t}C_{T,t} + P_{N,t}C_{N,t} = M_{t-1}. \tag{3.4}$$

The agent's nominal period budget constraint is given by

$$P_tB^*_{t+1} = P_t(1+r)B^*_t - (M_t - M_{t-1}) + P_tC_t + P_{T,t}\bar{Y}_T + p_{N,t}(z)y_{N,t}(z) + P_tg_t. \tag{3.5}$$

P_t, B^*_{t+1}, $\bar{Y}_T$ and g_t denote the price level, that is, the consumption-based price index (which will be explicitly derived later), real holdings of foreign bonds at the beginning of period $t+1$, the endowment of tradable goods and government net transfer to the private sector, respectively. $y_{N,t}(z)$ denotes the output produced by the firm which is owned by the agent indexed by z, $p_{N,t}(z)$ the price.[12] Equation (3.5), coupled with the transversality condition

[10] Clower (1967) is the pioneering work incorporating cash-in-advance constraints. Detailed treatments of sequenced opening hours in a stochastic environment can be found in Sargent (1987:158ff). The notation for prices used in the cash-in-advance constraint, that is, explicitly denoting the price levels of tradable and of non-tradable goods is adopted for the sake of expositional clarity. It is particularly useful for analyzing (temporary) changes in the nominal exchange rate. No fundamental difference exists between this notation and the more common practice of formulating everything in terms of the relative price of tradable goods.

[11] For the same reason, imports are not modeled to be subject to a foreign-cash-in-advance constraint.

[12] Notice that $p_{N,t}(z)y_{N,t}(z)$ is the sum of the nominal production cost and the profits of intermediate non-tradable goods production. The latter are given as

$\lim_{T\to\infty}(1+r)^{-T}\left(B^*_{t+T+1}+\frac{M_{t+T+1}}{P_{t+T+1}}\right)=0$ and the assumption that agents' initial asset holdings equal zero yields the intertemporal budget constraint as

$$\sum_{s=t}^{\infty}(1+r)^{t-s}C_s=\sum_{s=t}^{\infty}(1+r)^{t-s}\left[\frac{P_{T,s}}{P_s}\bar{y}_T+\frac{P_{N,s}}{P_s}Y_{N,s}+g_t-\frac{M_s-M_{s-1}}{P_s}\right]. \tag{3.6}$$

This chapter's analysis will show that the price charged and quantity supplied by each monopolist equal the aggregate non-tradables' price, $P_{N,t}$, and output of non-tradable final goods, $Y_{N,t}$. In anticipation on this result, $p_{N,t}(z)$ and $y_{N,t}(z)$ are therefore substituted with $P_{N,t}$ and $Y_{N,t}$ in what follows.

Substituting the cash-in-advance constraint into the period budget constraint the latter can be reformulated to yield

$$C_t=-\frac{P_{t-1}}{P_t}\left(B^*_t-(1+r)B^*_{t-1}\right)+\frac{P_{T,t-1}}{P_t}\bar{Y}_T+\frac{P_{N,t-1}}{P_t}Y_{N,t-1}+\frac{P_{t-1}}{P_t}g_t.$$

Substituting this expression for C into the intertemporal utility function and taking the derivative with respect to B^* gives rise to the following first-order condition for optimal consumption:

$$C_t\frac{P_t}{P_{t-1}}=C_{t+1}\frac{P_{t+1}}{P_t} \tag{3.7}$$

Equation (3.7) differs from the usual Euler equation as agents have to hold currency in the period prior to consumption. Defining the inflation rate between periods $t-1$ and t as $\pi_t\equiv\frac{P_t}{P_{t-1}}-1$, π_{t+1} as $\pi_{t+1}\equiv\frac{P_{t+1}}{P_t}-1$, the first-order condition can be reformulated to yield

$$\frac{\partial U(C_t)/\partial C_t}{1+\pi_t}=\frac{\partial U(C_{t+1})/\partial C_{t+1}}{1+\pi_{t+1}} \tag{3.8}$$

where $\partial U(C_t)/\partial C_t$ denotes the derivative of utility with respect to consumption, $\partial U(C_t)/\partial C_t=C_t^{-1}$. The above equation states that the marginal utility of consumption per unit of its cost must be equal across periods. Since consumption must be covered by the preceding period's money holdings, the cost of consumption includes the cost of holding money, that is, for money held between periods $t-1$ and t the inflation rate π_t, and π_{t+1} for money held

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$$p_{N,t}(z)y_{N,t+j}(z)-P_{t+j}MCy_{N,t+j}(z)$$

where $MC\ y_{N,t+j}(z)$ denotes the real production cost function.

between periods t and $t+1$. The first order condition shows that optimal consumption is constant in equilibria with a constant inflation rate.[13]

The first-order condition and the intertemporal budget constraint allow to derive a closed-form solution for optimal consumption as

$$C_t = (1+\pi_t)^{-1}\left[\sum_{s=t}^{\infty}(1+\pi_s)^{-1}(1+r)^{t-s}\right]^{-1} W_t$$

where W is defined as $W_t \equiv \sum_{s=t}^{\infty}(1+r)^{t-s}\left(\frac{P_{T,s}}{P_s}\bar{Y}_T + \frac{P_{N,s}}{P_s}Y_{N,s} + g_t - \frac{M_s - M_{s-1}}{P_s}\right)$. A detailed derivation of this expression for consumption can be found in appendix 3.6.1.

First-order condition (3.7) determines the optimal path for total consumption. The division of total consumption between tradable and non-tradable goods is found by maximizing total consumption, given total expenditure, that is, by maximizing

$$C_t = C_{T,t}^{\gamma} C_{N,t}^{1-\gamma}$$

subject to

$$\frac{P_{N,t}}{P_t}C_{N,t} + \frac{P_{T,t}}{P_t}C_{T,t} = Z_t$$

where Z_t equals total real expenditure on consumption. This yields[14]

$$C_{T,t} = \gamma \frac{1}{P_{T,t}} Z_t^{nom} \tag{3.9}$$

and

$$C_{N,t} = (1-\gamma)\frac{1}{P_{N,t}} Z_t^{nom} \tag{3.10}$$

where Z_t^{nom} denotes total nominal expenditure, $Z_t^{nom} = P_t Z_t$. Total real expenditure, Z_t, equals total real consumption, C_t. Therefore, above demand equations can be expressed as

$$C_{T,t} = \gamma \frac{P_t}{P_{T,t}} C_t$$

---

[13]Recall that the subjective discount factor and the real interest rate factor do not enter the first-order condition, as these were assumed to be equal.

[14]The derivation is as follows: In a first step, the Lagrange function $L = C_{T,t}^{\gamma} C_{N,t}^{1-\gamma} - \lambda(\frac{P_{N,t}}{P_t}C_{N,t} + \frac{P_{T,t}}{P_t}C_{T,t} - Z_t)$ is maximized with respect to $C_{T,t}$ and $C_{N,t}$. The ratio of first-order conditions gives relative consumption of non-tradables as $\frac{C_{N,t}}{C_{T,t}} = \frac{1-\gamma}{\gamma}\frac{P_{N,t}}{P_{T,t}}$. Substituting C_N and C_T with the values implied by the total expenditure function yields equations (3.9) and (3.10).

and

$$C_{N,t} = (1-\gamma)\frac{P_t}{P_{N,t}}C_t.$$

In a last step, the (consumption-based) price index P is derived. Following Obstfeld and Rogoff (1996:227), it is defined as the minimum nominal expenditure Z_t^{nom} required to acquire one unit of the consumption bundle.[15] Formally, this can be expressed as

$$P_t \equiv \left\{Z_t^{nom} | C(Z_t^{nom}) = 1\right\}.$$

Demand equations (3.9) and (3.10) maximize consumption, given spending Z^{nom}. The minimum expenditure to acquire one unit of C is thus found by substituting these demand functions into the definition of the consumption basket, equation (3.2), setting the resulting expression equal to one.

$$\left(\gamma\frac{1}{P_{T,t}}Z_t^{nom}\right)^{\gamma}\left((1-\gamma)\frac{1}{P_{N,t}}Z_t^{nom}\right)^{1-\gamma} = 1$$

Solving the above equation for Z_t^{nom} yields the price index as

$$P_t = \left(\frac{P_{T,t}}{\gamma}\right)^{\gamma}\left(\frac{P_{N,t}}{1-\gamma}\right)^{(1-\gamma)}. \qquad (3.11)$$

3.2.2 Production of Non-tradable Goods

The non-tradable goods sector is characterized by the following structure: Final non-tradable goods, Y_N, are produced competitively, using a continuum of intermediate inputs, y_N. Each of these intermediate goods is produced by a monopolist. It is assumed that intermediate good prices can be changed only every other period, that is, their producers set one price for periods t and $t+1$ at the beginning of period t. The monopolistic competition framework serves to render the assumption of sticky prices more plausible: Monopolistic producers possess some market power, and thus are able to set prices for their products. As shown by Akerlof and Yellen (1985) and Mankiw (1985), in the presence of menu costs these preset prices might not be changed in response to shocks.

The following sections will first derive the demand for non-tradable intermediate goods by analyzing the production of non-tradable final goods, and then turn to the production and pricing decision of intermediate goods' producers.

[15] The definition used here is not identical to Obstfeld and Rogoff's since they use tradable goods' prices as numeraire.

Production of Non-Tradable Final Goods

The production of non-tradable final goods uses non-tradable intermediate goods, indexed by $z \in [0,1]$, according to the following linear homogenous CES production function:

$$Y_N = \left[\int_0^1 y_N(z)^\theta dz \right]^{\frac{1}{\theta}} \tag{3.12}$$

where $0 < \theta < 1$. $y_N(z)$ denotes the intermediate goods, which the producers of final goods purchase at a price of $p_{N,s}(z)$. The real cost of producing final non-tradable goods thus amounts to $\left[P_{N,s}^{-1} \int_0^1 \left[y_{N,s}(z) p_{N,s}(z) \right] dz \right]$; the present value of final good producers' real profits is given as

$$\sum_{s=t}^{\infty} (1+r)^{s-t} \left[\left(\int_0^1 y_{N,s}(z)^\theta dz \right)^{\frac{1}{\theta}} - P_{N,s}^{-1} \int_0^1 y_{N,s}(z) p_{N,s}(z) dz \right].$$

Maximizing the above function with respect to y_N yields the demand for intermediate goods as

$$y_{N,t}(z) = \left(\frac{P_{N,t}}{p_{N,t}(z)} \right)^{\frac{1}{1-\theta}} Y_{N,t}. \tag{3.13}$$

Note that the price elasticity of demand faced by each monopolistic supplier of intermediate non-tradable goods is given by $\left| \frac{\partial y_{N,t} / \partial p_{N,t}}{y_{N,t} / p_{N,t}} \right| = \frac{1}{1-\theta}$. The price of non-tradable final goods, $P_{N,t}$, is the minimum nominal expenditure necessary to acquire one unit of Y_N. Analogously to the derivation of the consumption-based price index, it is calculated by substituting the demand of final goods' producers, equation (3.13), into the production function, and setting the resulting expression for Y_N equal to one:

$$1 = \left[\int_0^1 \left[\left(\frac{P_{N,t}}{p_{N,t}(z)} \right)^{\frac{1}{1-\theta}} \right]^\theta dz \right]^{\frac{1}{\theta}} \tag{3.14}$$

Solving above equation for P_N yields the minimum expenditure for acquiring one unit of Y_N as

$$P_{N,t} = \left[\int_0^1 p_{N,t}(z)^{\frac{\theta}{\theta-1}} dz \right]^{\frac{\theta-1}{\theta}}. \tag{3.15}$$

Non-tradable final goods are produced exclusively for domestic consumption. An equilibrium on the market for non-tradable final goods is thus given by

$$Y_{N,t} = C_{N,t}. \tag{3.16}$$

Intermediate Goods Production and Pricing

Suppliers of non-tradable intermediate goods are monopolists who are conscious of the above-derived demand function for their respective good. At the beginning of period t, each supplier sets the price for his good over two periods such that the present value of expected profits over these periods is maximized. Demand is then met at the posted price.

A producer of a particular non-tradable intermediate good chooses the price $p_{N,t}(z)$ which maximizes

$$\sum_{j=0}^{1}(1+r)^{-j}\left[\left(\frac{p_{N,t}(z)}{P_{t+j}}-MC\right)y_{N,t+j}(z)\right]. \tag{3.17}$$

$MC\ y_{N,t+j}(z)$ is the producer's cost function. MC denotes the constant real unit cost of producing the intermediate good.[16] The (unorthodox) assumption of constant average costs is imposed only as it greatly simplifies computations in what follows; replacing it by a cost function with increasing marginal costs would not change the results. Furthermore, it can be shown that the second-order conditions for profit maximization hold. Each price setter is assumed to be 'small' in the sense that he ignores the effect of his price on the overall price level and on aggregate demand for non-tradables. Since agents hold perfect foresight, expectation operators are omitted.

Maximizing the above function with respect to $p_{N,t}(z)$ yields the following first-order condition:

$$\theta p_{N,t}(z)\sum_{j=0}^{1}\left\{(1+r)^{-j}\,P_{N,t+j}^{\frac{1}{1-\theta}}Y_{N,t+j}\right\}=\sum_{j=0}^{1}\left\{(1+r)^{-j}\,MCP_{t+j}P_{N,t+j}^{\frac{1}{1-\theta}}Y_{N,t+j}\right\}$$

From this, the profit-maximizing price of non-tradable intermediate goods can be solved as

$$p_{N,t}(z)=\theta^{-\frac{1}{\gamma}}\gamma^{-1}(1-\gamma)^{1-\frac{1}{\gamma}}MC^{\frac{1}{\gamma}}\left[\frac{P_{T,t}^{\gamma}+(1+r)^{-1}\,P_{T,t+1}^{\gamma}\frac{Y_{N,t+1}}{Y_{N,t}}}{1+(1+r)^{-1}\frac{Y_{N,t+1}}{Y_{N,t}}}\right]^{\frac{1}{\gamma}}. \tag{3.18}$$

A detailed derivation of above expression is presented in the appendix 3.6.2 to this chapter. Equation (3.18) shows that all monopolistic competitors charge the same price for their good: The determinants of each producer's

[16]The intermediate goods' production functions are not spelled out explicitly in order to simplify the model. An example of a production function which yields the assumed cost function is the assumption of output as proportional to labor input, coupled with infinitely elastic labor supply.

price, namely, marginal cost, tradables' prices and aggregate demand for non-tradables, are equal across producers. Using $p_{N,t}(z) = p_{N,t}$ in the definition of final non-tradable goods' prices, equation (3.15), yields

$$P_{N,t} = p_{N,t}, \tag{3.19}$$

that is, in a symmetric equilibrium, the price of non-tradable final goods equals the price of non-tradable intermediate goods.[17]

Tradable Goods

Home agents are endowed with an amount $\bar{Y}_T$ of tradable goods. Supply of tradable goods from abroad is infinitely elastic. In absence of impediments to trade, purchasing power parity holds, that is, the price of tradable goods in the domestic economy equals their domestic-currency denominated price abroad.

$$P_{T,t} = E_t, \tag{3.20}$$

where E_t denotes the nominal exchange rate and the foreign price of tradable goods (in foreign currency) is normalized to one. Equilibrium in the market for tradable goods is given by the equality of supply and demand for these goods,

$$\bar{Y}_T + CA_t = C_{T,t} \tag{3.21}$$

where CA denotes net imports of goods.

3.2.3 The Money Market

Money demand is given by the cash-in-advance constraint: Given the positive nominal interest rate and perfect foresight, agents will hold exactly the amount of cash necessary for consuming. This implies nominal money demand of

$$M_t = C_{t+1} P_{t+1}.$$

It is assumed that money supply is determined by the government's financing requirements: Each period, the government pays out a net transfer of an exogenously given magnitude to households. The transfer is financed with seignorage revenues, which equal the sum of the inflation-tax proceeds, that is , the total capital loss inflation imposes on holders of real money

[17] Recall that this result has already been used in the previous section for the period budget constraint.

balances, and the change in the economy's real money holdings:[18]

$$\frac{M_t - M_{t-1}}{P_t} = \left(\frac{P_t - P_{t-1}}{P_t}\frac{M_{t-1}}{P_{t-1}}\right) + \left(\frac{M_t}{P_t} - \frac{M_{t-1}}{P_{t-1}}\right)$$

Given this financing pattern, money supply is given as

$$\frac{M_t - M_{t-1}}{P_t} = g_t. \tag{3.22}$$

The financing pattern described above implies that the government's fiscal and monetary branches are not separated, that is, that the fiscal branch can dictate the level of money supply, and all proceeds of money creation are transferred directly to the fiscal authorities.[19] g_t denotes the governments *net* transfers to the private sector, that is, the model does not rule out fiscal tax revenues. Similarly, the model's results do not hinge on the government's inability to borrow abroad. It could easily be extended to a version where only a certain fraction of net spending has to be covered with seignorage. As pointed out in section 1.2, this is a realistic assumption for the developing economies under consideration.

The government budget constraint implies that changes in reserve money have no effect on the economy's wealth. This can be shown by substituting above equation into the private sector's nominal budget constraint, which yields the economy's aggregate nominal budget constraint as

$$P_t B_{t+1} = P_t(1+r)B_t + P_t C_t + P_{T,t}\bar{Y}_T + P_{N,t}Y_{N,t}. \tag{3.23}$$

Thus far, the account of monetary policy and fiscal policy has focused on monetary aggregates: The central bank was assumed to increase reserve money – 'print money' – in order to finance government spending. During managed exchange rate regimes, however, nominal money supply is determined endogenously by the requirement to maintain the nominal exchange rate at the targeted level. The exchange rate target – coupled with money demand – then determines money supply. If, on the contrary, the central bank engages in seignorage-finance of government expenditure, the nominal exchange rate devalues. This can be further explored by reformulating the government budget constraint, which gives the increase in nominal money supply in period t as

$$M_t - M_{t-1} = P_t g_t.$$

[18]In models with nominal bonds, seignorage includes the capital loss inflation inflicts on holders of nominal government bonds. This effect is not present in this chapter's model, which assumes that the home government does not issue bonds.

[19]The fiscal and monetary authorities' separate and consolidated balance sheets are presented in appendix 4.7.1 to chapter 4.

The period change in money demand is given by the cash-in-advance constraint as $M_t - M_{t-1} = C_{t+1}P_{t+1} - C_tP_t$. Money market equilibrium thus implies

$$P_t g_t = C_{t+1}P_{t+1} - C_tP_t.$$

Substituting C_{t+1} with the expression implied by first-order condition (3.7) and reformulating yields

$$g_t = C_t \left[\frac{P_t}{P_{t-1}} - 1 \right].$$

The above equation shows that P_t must exceed P_{t-1} whenever net transfers are positive. As the aggregate price level is a function of $P_{N,t}$ and $P_{T,t}$, an increase in net transfers must be accompanied either by a rise in non-tradables' prices or an increase in the nominal exchange rate. Non-tradables' prices are set by their producers, and are thus only indirectly affected by government policy. The nominal exchange rate, in contrast, is under direct control of the government. An increase in net transfers g must hence be financed by increasing $P_{T,t} = E_t$, that is, currency devaluation.

3.2.4 Equilibrium in an Economy with a Constant Exchange Rate

This section derives characteristics of consumption and the real exchange rate for an economy with a constant nominal exchange rate. This establishes a benchmark against which to compare the effects of a temporary stabilization policy presented in the next section.

When the devaluation rate equals zero, the price of non-tradable goods can be shown to be constant, too. This follows from equation (3.18), which gives $P_{N,t}$ as

$$P_{N,t} = \theta^{-\frac{1}{\gamma}} \gamma^{-1} (1-\gamma)^{1-\frac{1}{\gamma}} MC^{\frac{1}{\gamma}} P_{T,t} \left[\frac{1 + (1+r)^{-1} \left(\frac{P_{T,t+1}}{P_{T,t}} \right)^{\gamma} \frac{Y_{N,t+1}}{Y_{N,t}}}{1 + (1+r)^{-1} \frac{Y_{N,t+1}}{Y_{N,t}}} \right]^{\frac{1}{\gamma}}. \quad (3.24)$$

When tradables' prices are constant, that is, $\bar{P}_T = P_{T,t+1} = P_{T,t}$, the above equation simplifies to

$$P_{N,t} = \theta^{-\frac{1}{\gamma}} \gamma^{-1} (1-\gamma)^{1-\frac{1}{\gamma}} MC^{\frac{1}{\gamma}} \bar{P}_T$$

which shows that the price of non-tradable goods is constant and proportional to the one of tradable goods. The demand functions for tradable and non-tradable goods, equations (3.9) and (3.10), then imply that the consumption of tradable relative to non-tradable goods is constant:

$$\frac{C_{T,t}}{C_{N,t}} = \frac{\gamma}{1-\gamma}\frac{\bar{P}_N}{\bar{P}_T} = const.$$

Furthermore, constant tradables' and non-tradables' prices imply that the overall price level is constant, too. First-order condition (3.7) shows that aggregate consumption is constant:

$$\frac{C_t}{C_{t+1}} = \frac{P_{t+1}}{P_t}\frac{P_{t-1}}{P_t} = 1$$

Coupled with the intertemporal budget constraint, this implies that period consumption must equal period income, that is, the sum of the output of non-tradable goods and the endowment of tradable goods.

The real exchange rate is defined as the ratio of the foreign and the domestic economies' price levels, both expressed in domestic currency. Substituting the aggregate price level with the expression given by equation (3.11), the real exchange rate can be reformulated to yield

$$\frac{E_t}{P_t} = \frac{P_{T,t}}{P_t} = \gamma^{\gamma}(1-\gamma)^{1-\gamma}\left(\frac{\bar{P}_T}{\bar{P}_N}\right)^{1-\gamma}.$$

Given constant prices of tradable and non-tradable goods, the real exchange rate is constant.

In sum, an economy with a permanently constant exchange rate is characterized by constant prices, consumption, output and a constant real exchange rate. The next section examines dynamics in an economy where the nominal exchange rate is subject to exogenous changes.

3.2.5 Non-Credible, Temporary Stabilization

This section analyzes the central policy experiment of this chapter: The consumption and real exchange rate dynamics resulting from a perfectly anticipated increase in the rate of nominal currency devaluation. This devaluation can be thought to mark the end of an ERBS in which the government aimed at permanently stabilizing the nominal exchange rate at a lower level. According to the government budget constraint, this must be associated with a reduction in net government spending. The government achieved to implement lower spending during one period, but is then pressured to reverse the spending cut and pay out positive net transfers.[20] In order to finance these,

[20] The pressure can plausibly be thought to originate from the interest groups most affected by the spending cuts.

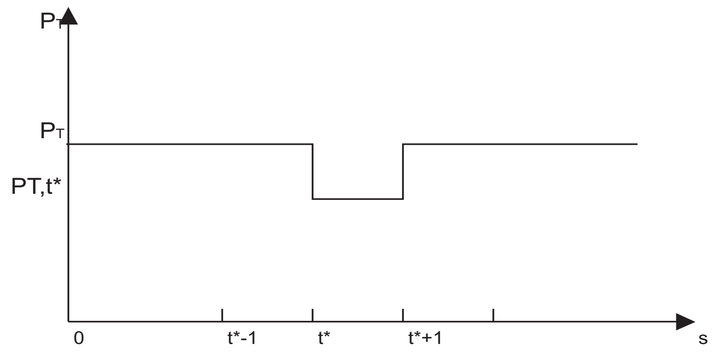

Figure 3.2: The price of tradable goods during stabilization

the government must sacrifice its nominal exchange rate target – recall that the only means of generating revenue are increases in the nominal money supply, implying an increased devaluation rate. This nominal exchange rate path is *perfectly anticipated* by private agents, that is, agents do not believe in the government's initial announcement of a permanently lower nominal exchange rate. The temporary peg is thus equivalent to a non-credible peg.

In sum, the nominal exchange rate path is as follows: The nominal exchange rate is at a level of $\bar{P}_T$ prior to the 'stabilization', where 'stabilization' denotes the period in which the exchange rate is targeted. It is lowered to a level denoted $P_{T,t^*} < \bar{P}_T$ at the beginning of period t^*, denoted as the 'stabilization period'. At the beginning of period t^*+1, the nominal exchange rate rises to its pre-stabilization level of $\bar{P}_T$ and remains there indefinitely. Formally, this can be expressed as

$$\begin{aligned} P_{T,s} &= \bar{P}_T \text{ for all } s \in \{0, \infty | s \neq t^*\} \qquad (3.25) \\ P_{T,s} &= P_{T,s} < \bar{P}_T \text{ for } s = t^*. \end{aligned}$$

Figure 3.2 graphs this nominal exchange rate path, and figure 3.3 (on page 105) recapitulates the timing in the model.

The above account of a transitory stabilization policy captures two important features of 'real world' ERBS: The nominal exchange rate target is abandoned due to increased government spending, and the end of exchange rate targeting is associated with a rise in currency devaluation. The main

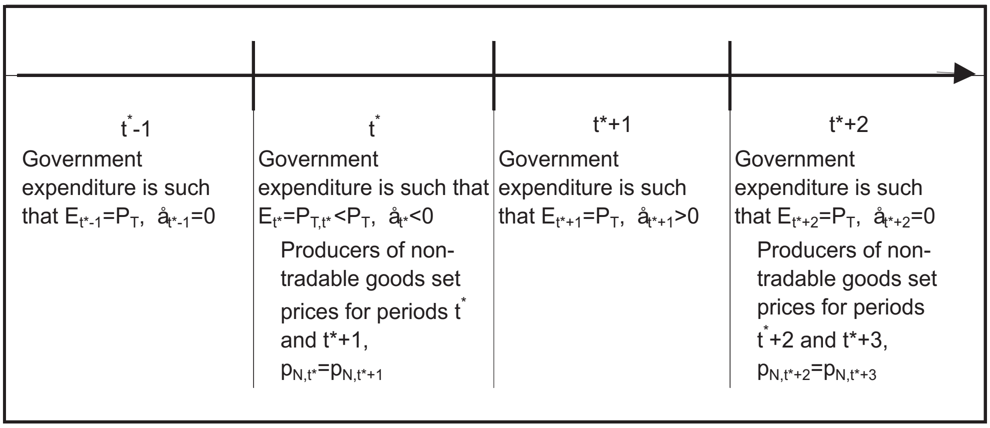

Figure 3.3: The timing in the model

purpose of my model is to assess the effects of this anticipated devaluation rate increase. Therefore, a simplification seems admissible: The exchange rate path (3.25) assumes that stabilization is a reduction of the nominal exchange rate's *level*. This differs from actual ERBS which typically aim at a lower *rate* of currency devaluation. However, my results equally hold in a model with a constant steady state devaluation rate which is temporarily reduced during transitory stabilization. In this extension, the price setting rule must be slightly altered: In period 0, each producer of a non-tradable intermediate good sets a constant rate of price increase. Additionally, he can alter his price discretely every other period. It can be shown that profit-maximizing producers set the constant rate of price increase equal to the steady state devaluation rate. The exchange rate and price paths presented above can therefore be interpreted as the exchange rate and price dynamics which remain when the economy's exogenous steady state devaluation is subtracted.

In what follows, the effects of the fully anticipated devaluation rate increase – as implied by the nominal exchange rate path (3.25) – are explored. The analysis will first present the formal proof for the respective effect, and then elaborate on its intuition.

With regard to consumption, the following can be stated:

Proposition 1 *Aggregate consumption increases during the stabilization period.*

Proof:

From the first-order condition (3.7), the ratio of consumption in the stabilization and in the post-stabilization period is given as

$$\frac{C_{t^*}}{C_{t^*+1}} = \frac{P_{t^*+1}}{P_{t^*}}\frac{P_{t^*-1}}{P_{t^*}}.$$

The above equation shows that C_{t^*} unequivocally exceeds C_{t^*+1} if the price level decreases in the stabilization period, that is, if both $P_{t^*} < P_{t^*+1}$ and $P_{t^*} < P_{t^*-1}$.

To begin with, the first of these inequalities, that is, $\frac{P_{t^*}}{P_{t^*+1}} < 1$, will be shown to hold. The ratio of the periods t^* and the t^*+1 price levels is given by

$$\frac{P_{t^*}}{P_{t^*+1}} = \left(\frac{P_{T,t^*}}{P_{T,t^*+1}}\right)^{\gamma}\left(\frac{P_{N,t^*}}{P_{N,t^*+1}}\right)^{1-\gamma} \tag{3.26}$$

where I have used the fact that the price index P_t is defined as a geometric average of non-tradables' and tradables' prices. Tradable goods' prices are determined exogenously by the assumed nominal exchange rate path (3.25) which defines that P_{T,t^*} is smaller than P_{T,t^*+1}. The price setting process for non-tradable goods imposes the constraint that P_{N,t^*+1} equals P_{N,t^*}. Thus, the equation (3.26) is smaller than one, that is, the price level in period t^* is lower than in period t^*+1. The intuition for this is straightforward: As tradable prices are assumed to increase in period t^*+1 and non-tradables' prices are constant over periods t^* and t^*+1, the overall price level increases.

In a next step, I show that P_{t^*} is smaller than P_{t^*-1}. This is more involved, as period t^* non-tradables' prices depend positively on both (reduced) current and (increased) future tradable goods' prices. The price of non-tradable goods is given by the producer's profit maximization as

$$P_{N,t^*} = \gamma^{-1}(1-\gamma)^{-\frac{1-\gamma}{\gamma}}\theta^{-\frac{1}{\gamma}}MC^{\frac{1}{\gamma}}\ P_{T,t^*}\left[\frac{1+(1+r)^{-1}\left(\frac{P_{T,t^*+1}}{P_{T,t^*}}\right)^{\gamma}\frac{Y_{N,t^*+1}}{Y_{N,t^*}}}{1+(1+r)^{-1}\frac{Y_{N,t^*+1}}{Y_{N,t^*}}}\right]^{\frac{1}{\gamma}}.$$

Even though each individual price setter considers Y_{N,t^*} and Y_{N,t^*+1} to be exogenous, these are endogenous to the model: Goods market equilibrium implies that Y_N is equal to the demand for non-tradables, given by

$$C_{N,t^*} = (1-\gamma)\frac{P_{t^*}}{P_{N,t^*}}C_{t^*}.$$

$\frac{Y_{N,t^*+1}}{Y_{N,t^*}}$ can thus be reformulated to yield

$$\frac{Y_{N,t^*+1}}{Y_{N,t^*}} = \left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right)^{\gamma}\left(\frac{P_{N,t^*}}{P_{N,t^*-1}}\right)^{1-\gamma}\left(\frac{P_{N,t^*}}{P_{N,t^*+1}}\right)$$

where I have used the fact that the first-order condition for optimal consumption implies that $\frac{C_{t^*+1}}{C_{t^*}} = \frac{P_{t^*}}{P_{t^*+1}} \frac{P_{t^*}}{P_{t^*-1}}$. Recall that the assumed price setting rule imposes that $P_{N,t^*} = P_{N,t^*+1}$.

Substituting the above expression for $\frac{Y_{N,t^*+1}}{Y_{N,t^*}}$ in the equation for P_{N,t^*} yields

$$P_{N,t^*} = \gamma^{-1}(1-\gamma)^{-\frac{1-\gamma}{\gamma}}\theta^{-\frac{1}{\gamma}}MC^{\frac{1}{\gamma}}P_{T,t^*}\left[\frac{1+(1+r)^{-1}\left(\frac{P_{T,t^*+1}}{P_{T,t^*-1}}\right)^{\gamma}\left(\frac{P_{N,t^*}}{P_{N,t^*-1}}\right)^{1-\gamma}}{1+(1+r)^{-1}\left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right)^{\gamma}\left(\frac{P_{N,t^*}}{P_{N,t^*-1}}\right)^{1-\gamma}}\right]^{\frac{1}{\gamma}}. \tag{3.27}$$

Similarly, P_{N,t^*-1} can be expressed as

$$P_{N,t^*-1} = \gamma^{-1}(1-\gamma)^{-\frac{1-\gamma}{\gamma}}\theta^{-\frac{1}{\gamma}}MC^{\frac{1}{\gamma}}P_{T,t^*-1}\left[\frac{1+(1+r)^{-1}\left(\frac{P_{T,t^*}}{P_{T,t^*-2}}\right)^{\gamma}\left(\frac{P_{N,t^*-1}}{P_{N,t^*}}\right)}{1+(1+r)^{-1}\left(\frac{P_{N,t^*-1}}{P_{N,t^*}}\right)}\right]^{\frac{1}{\gamma}} \tag{3.28}$$

where I have used the fact that $P_{N,t^*-1} = P_{N,t^*-2}$ – non-tradables' prices are changed in even periods only – and that $P_{T,t^*-1} = P_{T,t^*-2}$ is given by the exogenously assumed nominal exchange rate path. The above equations yield the ratio of non-tradables' prices in periods t^* and t^*-1 as

$$\frac{P_{N,t^*}}{P_{N,t^*-1}}=\frac{P_{T,t^*}}{P_{T,t^*-1}}\left[\frac{1+(1+r)^{-1}\left(\frac{P_{T,t^*+1}}{P_{T,t^*-1}}\right)^{\gamma}\left(\frac{P_{N,t^*}}{P_{N,t^*-1}}\right)^{1-\gamma}}{1+(1+r)^{-1}\left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right)^{\gamma}\left(\frac{P_{N,t^*}}{P_{N,t^*-1}}\right)^{1-\gamma}}\frac{1+(1+r)^{-1}\left(\frac{P_{N,t^*-1}}{P_{N,t^*}}\right)}{1+(1+r)^{-1}\left(\frac{P_{T,t^*}}{P_{T,t^*-2}}\right)^{\gamma}\left(\frac{P_{N,t^*-1}}{P_{N,t^*}}\right)}\right]^{\frac{1}{\gamma}}.$$

The ratio of the overall price levels in periods t^* and t^*-1 is given as

$$\frac{P_{t^*}}{P_{t^*-1}} = \left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right)^{\gamma}\left(\frac{P_{N,t^*}}{P_{N,t^*-1}}\right)^{1-\gamma}. \tag{3.29}$$

Substituting $\frac{P_{N,t^*}}{P_{N,t^*-1}}$ in the above equation and rearranging terms yields the ratio of the overall price levels in periods t^* and t^*-1 as

$$\begin{aligned}\frac{P_{t^*}}{P_{t^*-1}} &= \left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right)\left(\frac{\left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right)^{\gamma}+(1+r)^{-1}\left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right)^{\gamma}\left(\frac{P_{N,t^*}}{P_{N,t^*-1}}\right)^{1-\gamma}}{1+(1+r)^{-1}\left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right)^{\gamma}\left(\frac{P_{N,t^*}}{P_{N,t^*-1}}\right)^{1-\gamma}}\right)^{\frac{1-\gamma}{\gamma}}\cdot \\ &\quad\cdot\left(\frac{\left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right)^{\gamma}+(1+r)^{-1}\left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right)^{\gamma}\left(\frac{P_{N,t^*-1}}{P_{N,t^*}}\right)}{1+(1+r)^{-1}\left(\frac{P_{T,t^*}}{P_{T,t^*-2}}\right)^{\gamma}\left(\frac{P_{N,t^*-1}}{P_{N,t^*}}\right)}\right)^{\frac{1-\gamma}{\gamma}}.\end{aligned} \tag{3.30}$$

In order to show that the price level decreases during temporary stabilization, that is, in period t^*, each of the three terms of the above expression is analyzed. By the very definition of stabilization, the first term is smaller than one. The magnitude of the second term can easily be assessed when expressing it as

$$\left(\frac{\left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right)^{\gamma}+A}{1+A}\right)^{\frac{1-\gamma}{\gamma}}$$

where A is defined as $A \equiv (1+r)^{-1}\left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right)^{\gamma}\left(\frac{P_{N,t^*}}{P_{N,t^*-1}}\right)^{1-\gamma}$. Once more, it just needs to be recalled that P_{T,t^*} falls during stabilization to find out that this second term is smaller than one as well. Similarly, the third term can be re-defined to yield

$$\left(\frac{\left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right)^{\gamma}+B}{1+B}\right)^{\frac{1-\gamma}{\gamma}}$$

where I have used the fact that P_{T,t^*-1} equals P_{T,t^*-2}, implying that $\left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right) = \left(\frac{P_{T,t^*}}{P_{T,t^*-2}}\right)$, and $B \equiv (1+r)^{-1}\left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right)^{\gamma}\left(\frac{P_{N,t^*-1}}{P_{N,t^*}}\right)$. Hence, the third term of equation (3.30) is smaller than one, too, which implies that P_{t^*} is smaller than P_{t^*-1}, that is, the overall price level decreases during temporary stabilization.

Having shown that P_{t^*} increases both with respect to P_{t^*-1} and P_{t^*+1}, it is now known that consumption increases during temporary stabilization, that is, C_{t^*} increases relative to C_{t^*+1}. $\square$

What is the intuition for the rise in consumption? The government's period t^* exchange rate target effects a fall in tradable goods' prices. As shown above, this decrease in tradables' prices is associated with a lower overall price level. Since the cash-in-advance constraint requires agents to hold money prior to consuming, the effective cost of consumption includes the capital loss or gain on holding real money balances due to nominal price changes. A fall in prices implies that the real value of money balances increases, which reduces the effective price of consumption. Therefore, period t^* consumption increases. In sum, the rise in consumption results from intertemporal consumption substitution as a response to intertemporal price changes. As pointed out in section 1.5, this mechanism was originally proposed in a simpler modeling framework by Calvo (1986).

The next proposition considers the real exchange rate movements caused by the temporary devaluation rate decrease.

Proposition 2 *The real exchange rate appreciates during temporary stabilization.*

Proof:
The real exchange rate is defined as the ratio of the foreign and the domestic price levels, both expressed in home currency. Since PPP holds and the price level abroad is normalized to 1, the real exchange rate can be expressed as $\frac{P_{T,t}}{P_t}$. Substituting P_t with the expression implied by equation (3.11), this can be reformulated to yield

$$\frac{P_{T,t}}{P_t} = \gamma^{\gamma}(1-\gamma)^{1-\gamma}\left(\frac{P_{T,t}}{P_{N,t}}\right)^{1-\gamma}. \tag{3.31}$$

The above equation shows that the real exchange rate is a strictly increasing function of the relative price of tradable goods, which allows to focus on the latter when assessing real exchange rate movements. The real exchange rate appreciates in period t^* when the relative price of tradable goods decreases during period t^*, that is, when

$$\left(\frac{P_{T,t^*}}{P_{N,t^*}} : \frac{P_{T,t^*-1}}{P_{N,t^*-1}}\right) < 1.$$

This can be shown to hold: The relative price of tradables in period t^* is given as

$$\frac{P_{T,t^*}}{P_{N,t^*}} = \theta^{\frac{1}{\gamma}}\gamma(1-\gamma)^{\frac{1-\gamma}{\gamma}} MC^{-\frac{1}{\gamma}} \frac{\left[1+(1+r)^{-1}\left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right)^{\gamma}\left(\frac{P_{N,t^*}}{P_{N,t^*-1}}\right)^{1-\gamma}\right]^{\frac{1}{\gamma}}}{\left[1+(1+r)^{-1}\left(\frac{P_{T,t^*+1}}{P_{T,t^*-1}}\right)^{\gamma}\left(\frac{P_{N,t^*}}{P_{N,t^*-1}}\right)^{1-\gamma}\right]^{\frac{1}{\gamma}}} \tag{3.32}$$

and $\frac{P_{T,t^*-1}}{P_{N,t^*-1}}$ as

$$\frac{P_{T,t^*-1}}{P_{N,t^*-1}} = \theta^{\frac{1}{\gamma}}\gamma(1-\gamma)^{\frac{1-\gamma}{\gamma}} MC^{-\frac{1}{\gamma}} \frac{\left[1+(1+r)^{-1}\left(\frac{P_{N,t^*-1}}{P_{N,t^*}}\right)\right]^{\frac{1}{\gamma}}}{\left[1+(1+r)^{-1}\left(\frac{P_{T,t^*}}{P_{T,t^*-2}}\right)^{\gamma}\left(\frac{P_{N,t^*-1}}{P_{N,t^*}}\right)\right]^{\frac{1}{\gamma}}}. \tag{3.33}$$

The real exchange rate appreciates in period t^* if $\frac{P_{T,t^*}}{P_{N,t^*}} < \frac{P_{T,t^*-1}}{P_{N,t^*-1}}$, that is, if

$$\frac{1+(1+r)^{-1}\left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right)^{\gamma}\left(\frac{P_{N,t^*}}{P_{N,t^*-1}}\right)^{1-\gamma}}{1+(1+r)^{-1}\left(\frac{P_{T,t^*+1}}{P_{T,t^*-1}}\right)^{\gamma}\left(\frac{P_{N,t^*}}{P_{N,t^*-1}}\right)^{1-\gamma}} < \frac{1+(1+r)^{-1}\left(\frac{P_{N,t^*-1}}{P_{N,t^*}}\right)}{1+(1+r)^{-1}\left(\frac{P_{T,t^*}}{P_{T,t^*-2}}\right)^{\gamma}\left(\frac{P_{N,t^*-1}}{P_{N,t^*}}\right)}. \tag{3.34}$$

One possibility to show that the above inequality holds is to demonstrate that the value of its left hand side is below one, and the expression on the right hand side greater than one for all prices and parameters in the ranges initially assumed (in particular, $0 < \gamma < 1$). This can be shown to hold: The left hand side of equation (3.34) is smaller than one if

$$1+(1+r)^{-1}\left(\frac{P_{T,t^*}}{P_{T,t^*-1}}\right)^{\gamma}\left(\frac{P_{N,t^*}}{P_{N,t^*-1}}\right)^{1-\gamma} < 1+(1+r)^{-1}\left(\frac{P_{T,t^*+1}}{P_{T,t^*-1}}\right)^{\gamma}\left(\frac{P_{N,t^*}}{P_{N,t^*-1}}\right)^{1-\gamma}$$

which can be reduced to the following inequality:

$$P_{T,t^*} < P_{T,t^*+1}$$

The above inequality is fulfilled, since the exogenously given nominal exchange rate path (3.25) exactly assumes that $P_{T,t}$ falls in period t^*. Thus, the left hand side of inequality (3.34) is smaller than one. Similarly, it can be shown that the right hand side exceeds one, as, by assumption, $\frac{P_{T,t^*}}{P_{T,t^*-2}} < 1$. Thus, inequality (3.34) holds and the real exchange rate appreciates during the temporary peg. □

The mechanism underlying the real exchange rate appreciation is a novel feature of this chapter's model: As pointed out in section 1.5, most of the existing models of ERBS explain the real appreciation with increases of relative non-tradables' prices stemming from *excess demand* for these goods. The model proposed in this chapter explains the real appreciation with *forward-looking price setting*: Non-tradables producers anticipate the jump of the nominal exchange rate when setting their prices over periods t and $t+1$ by maximizing the present value of their profits over these periods at the beginning of period t. Via PPP, a rise in the nominal exchange rate is equivalent to an increase in tradable goods' prices, which enter the profit function as a component of nominal costs. Therefore, the future increase in tradable goods' prices is reflected in relatively higher current prices of non-tradables, thus giving rise to the real appreciation.

Given that the previous two propositions indicate that temporary stabilization is accompanied by an increase in demand and a real appreciation, it is straightforward to demonstrate that the consumption of tradable goods rises and the current account deteriorates during stabilization. This is shown analytically below.

Proposition 3 *The consumption of tradable goods increases in period t^*, both in absolute value and relative to non-tradable consumption. The current account deteriorates.*

Proof:

In a first step, it will be shown that $C_{T,t}$ increases in absolute value. From equation (3.9), the ratio of period t^* and t^*+1 tradables consumption can be derived as

$$\frac{C_{T,t^*}}{C_{T,t^*-1}} = \frac{P_{t^*}}{P_{t^*-1}} \frac{P_{T,t^*-1}}{P_{T,t^*}} \frac{C_{t^*}}{C_{t^*-1}}.$$

Substituting $\frac{C_{t^*}}{C_{t^*-1}}$ with the expression given by the first-order condition (3.7), this can be reformulated to yield

$$\frac{C_{T,t^*}}{C_{T,t^*-1}} = \frac{P_{T,t^*-1}}{P_{T,t^*}} \frac{P_{t^*-1}}{P_{t^*-2}}.$$

P_{t^*-1} equals P_{t^*-2}, as both tradables' and non-tradables' prices are constant over periods t^*-1 and t^*-2. P_{T,t^*} is smaller than P_{T,t^*-1}, which implies that C_{T,t^*} exceeds C_{T,t^*-1}. Thus, the consumption of tradable goods rises during the peg. The intuition for this is straightforward: As the price of tradable goods falls, consumption demand for these goods rises.

Relative consumption of tradable goods is given as

$$\frac{C_T}{C_N} = \frac{\gamma}{1-\gamma} \frac{P_N}{P_T}. \tag{3.35}$$

In the proof of proposition 2, $\frac{P_N}{P_T}$ has been shown to increase in period t^*. Thus, as the relative price of tradable goods falls, the consumption of these goods rises relative to the consumption of non-tradable goods.

Coupled with the assumption that agents are endowed with a constant amount of tradable goods, the rise in the consumption of tradable goods implies that the current account moves into deficit: The consolidated intertemporal budget constraint requires that the present value of the economy's lifetime resources must equal the present value of its lifetime expenditures. This implies that the present value of all current account deficits or surpluses must equal zero:

$$\sum_{s=t}^{\infty} (1+r)^{t-s} \left(C_{T,t} - \bar{y}_T\right) = 0$$

Proposition 3 retains that C_{T,t^*} exceeds tradables consumption realized in periods preceding or following t^*. This is compatible with the intertemporal budget constraint only if $C_{T,t} < \bar{y}_T \forall t \neq t^*$ and $C_{T,t^*} > \bar{y}_T$. Hence, the current account will move into deficit in period t^*. □

In sum, given the constant endowment of tradable goods, the current account deterioration results from the increased consumption of tradable goods. The latter arises through two mechanisms: The temporary fall in tradables' prices effects intertemporal substitution of tradable goods consumption into the period where prices are lower. The fall in the relative price of tradable goods gives rise to intersectoral consumption substitution: Relatively more expensive non-tradable goods are replaced with (imported) tradable goods.

The model proposed in this section is capable of reproducing the main stylized facts of ERBS, namely, the consumption boom-slowdown cycle, the current account deficit and the real exchange rate appreciation. The latter is explained without recurring to excess demand for non-tradable goods, the channel present in most other models of ERBS, but relies on forward-looking price setting. The anticipated transitoriness of stabilization is crucial for the proposed explanation, implying that it is most appropriate for stabilization efforts perceived to be non-credible.

3.3 Modifying Intermediate Goods Pricing: Taylor Contracts

So far, the simplest possible form of price stickiness – the simultaneous re-negotiation of all non-tradables' prices every second period – has been assumed. This allowed to derive the consumption, real exchange rate and current account dynamics analytically. This section shows that the model's main results remain valid when assuming overlapping price contracts à la Taylor (1979, 1980), that is, multi-period nominal contracts with only a fraction of prices re-negotiated each period.[21] The motivation for this extension is twofold: First, it enables me to show that the model's results do not hinge on a restrictive assumption about price setting. Second, Taylor pricing generates richer dynamics, as it imparts both forward- and backward-looking aspects to non-tradables' prices and the real exchange rate.

To develop a simple example, each producer of intermediate goods is assumed to set his price for two periods, with a fraction α of intermediate goods' producers adjusting in periods $t+i$, $i = \{0, 2, 4, 6, ..\}$, and a fraction $(1-\alpha)$ in periods $t+i+1$. Price setters of the first group are characterized by the superscript I, those of the second group by the superscript II.

A group I producer sets his price $p_{N,t}(z) = p_{N,t+1}(z)$ such that the present value of his profits over periods t and $t+1$ is maximized, that is, he maximizes

[21] Another widely-used variant of price adjustment has been proposed by Calvo, 1983. He assumes that every individual firm adjusts its price with a constant, exogenously given probability each period. For open economy models with partial adjustment, see for example Ambler and Harb, 1999 and Kollmann, 1997. Introducing partial adjustment of prices would not change my model's main results.

the following function:

$$\sum_{j=0}^{1}(1+r)^{-j}\left(\frac{p_{N,t}(z)}{P_{t+j}}-MC\right)y_{N,t+j}(z). \tag{3.36}$$

As in the previous section, $y_{N,t}$ is given by the final good producer's demand for non-tradable intermediate goods, equation (3.13). The only difference to the profit maximization problem considered in the previous section is that period t and $t+1$ aggregate non-tradables' prices now also depend on the price set by group II producers.

Profit maximization yields $p^{I}_{N,t}(z)$ as

$$p^{I}_{N,t}(z)=\theta^{-1}MC\left[\frac{P_tP_{N,t}^{\frac{1}{1-\theta}}Y_{N,t}+(1+r)^{-1}P_{t+1}P_{N,t+1}^{\frac{1}{1-\theta}}Y_{N,t+1}}{P_{N,t}^{\frac{1}{1-\theta}}Y_{N,t}+(1+r)^{-1}P_{N,t+1}^{\frac{1}{1-\theta}}Y_{N,t+1}}\right] \tag{3.37}$$

where, as in the previous section, it is assumed that each individual producer ignores the effect of his price on aggregate prices and output. The above equation shows that all group I producers charge the same price, that is,

$$P^{I}_{N,t}=p^{I}_{N,t}(z)\ \forall\ z.$$

The period t price of non-tradable final goods is given as a geometric average of the prices charged by group I and group II producers. Group I producers charge t. Group II producers, who must hold their price constant over periods $t-1$ and t, charge the price set in period $t-1$. $P_{N,t}$ is thus given as

$$P_{N,t}=(p^{I}_{N,t})^{\alpha}(p^{II}_{N,t-1})^{1-\alpha} \tag{3.38}$$

and the period $t+1$ price level as

$$P_{N,t+1}=(p^{I}_{N,t})^{\alpha}(p^{II}_{N,t+1})^{1-\alpha}. \tag{3.39}$$

Substituting $P_{N,t}$ and $P_{N,t+1}$ with the expressions implied by the above equations, and P_t and P_{t+1} with equation (3.11), equation (3.37) yields $p^{I}_{N,t}$ as

$$p^{I}_{N,t}(z)=\left[\Phi p_{N,t-1}^{II\ (1-\alpha)(1-\gamma)}\frac{P^{\gamma}_{T,t}+(1+r)^{-1}\frac{Y_{N,t+1}}{Y_{N,t}}\left(\frac{p^{II}_{N,t+1}}{p^{II}_{N,t-1}}\right)^{\frac{(1-\alpha)[1+(1+\gamma)(1-\theta)]}{(1-\theta)}}P^{\ \gamma}_{T,t+1}}{1+(1+r)^{-1}\frac{Y_{N,t+1}}{Y_{N,t}}\left(\frac{p^{II}_{N,t+1}}{p^{II}_{N,t-1}}\right)^{\frac{1-\alpha}{1-\theta}}}\right]^{\frac{1}{1-\alpha(1-\gamma)}} \tag{3.40}$$

where Φ is defined as $\Phi \equiv \theta^{-1}\gamma^{-1}(1-\gamma)^{1-\frac{1}{\gamma}}MC$. Note that, when the price of tradable goods and those set by group II are constant, p_N^I is constant and equal to

$$p_{N,t}^I(z) = \left[\theta^{-1}\gamma^{-1}(1-\gamma)^{1-\frac{1}{\gamma}}MC\right]^{\frac{1}{\gamma}} \bar{P}_T.$$

Profit maximization of group II producers yields $p_{N,t-1}^{II}(z)$ as

$$p_{N,t-1}^{II}(z) = \left[\Phi p_{N,t-2}^{I\ (1-\alpha)(1-\gamma)} \frac{P_{T,t-1}^{\gamma} + (1+r)^{-1}\frac{Y_{N,t}}{Y_{N,t-1}}\left(\frac{p_{N,t}^I}{p_{N,t-2}^I}\right)^{\frac{(1-\alpha)[1+(1+\gamma)(1-\theta)]}{(1-\theta)}} P_{T,t}^{\gamma}}{1+(1+r)^{-1}\frac{Y_{N,t}}{Y_{N,t-1}}\left(\frac{p_{N,t}^I}{p_{N,t-2}^I}\right)^{\frac{1-\alpha}{1-\theta}}}\right]^{\frac{1}{1-\alpha(1-\gamma)}}. \tag{3.41}$$

Substituting equations (3.40) and (3.41) in equation (3.38) yields the period t price level of non-tradable goods as

$$\begin{aligned} P_{N,t} &= \Phi^{\frac{1}{1-\alpha(1-\gamma)}}\left[\left(p_{N,t-1}^{II}\right)^{\alpha}\left(p_{N,t-2}^{I}\right)^{(1-\alpha)}\right]^{\frac{(1-\alpha)(1-\gamma)}{1-\alpha(1-\gamma)}} \cdot \\ &\cdot\left(\frac{P_{T,t}^{\gamma} + (1+r)^{-1}\frac{Y_{N,t+1}}{Y_{N,t}}\left(\frac{p_{N,t+1}^{II}}{p_{N,t-1}^{II}}\right)^{\frac{(1-\alpha)[1+(1+\gamma)(1-\theta)]}{(1-\theta)}} P_{T,t+1}^{\gamma}}{1+(1+r)^{-1}\frac{Y_{N,t+1}}{Y_{N,t}}\left(\frac{p_{N,t+1}^{II}}{p_{N,t-1}^{II}}\right)^{\frac{1-\alpha}{1-\theta}}}\right)^{\frac{\alpha}{1-\alpha(1-\gamma)}} \cdot \\ &\cdot\left(\frac{P_{T,t-1}^{\gamma} + (1+r)^{-1}\frac{Y_{N,t}}{Y_{N,t-1}}\left(\frac{p_{N,t}^{I}}{p_{N,t-2}^{I}}\right)^{\frac{(1-\alpha)[1+(1+\gamma)(1-\theta)]}{(1-\theta)}} P_{T,t}^{\gamma}}{1+(1+r)^{-1}\frac{Y_{N,t}}{Y_{N,t-1}}\left(\frac{p_{N,t}^{I}}{p_{N,t-2}^{I}}\right)^{\frac{1-\alpha}{1-\theta}}}\right)^{\frac{1-\alpha}{1-\alpha(1-\gamma)}}. \end{aligned} \tag{3.42}$$

and the relative price of tradable goods as

$$\begin{aligned} \frac{P_{T,t}}{P_{N,t}} &= \Phi^{-\frac{1}{1-\alpha(1-\gamma)}} P_{T,t}^{\frac{1-\alpha}{1-\alpha(1-\gamma)}}\left[\left(p_{N,t-1}^{II}\right)^{\alpha}\left(p_{N,t-2}^{I}\right)^{(1-\alpha)}\right]^{-\frac{(1-\alpha)(1-\gamma)}{1-\alpha(1-\gamma)}} \cdot \\ &\cdot\left(\frac{1 + (1+r)^{-1}\frac{Y_{N,t+1}}{Y_{N,t}}\left(\frac{p_{N,t+1}^{II}}{p_{N,t-1}^{II}}\right)^{\frac{(1-\alpha)[1+(1+\gamma)(1-\theta)]}{(1-\theta)}} \left(\frac{P_{T,t+1}^{\gamma}}{P_{T,t}^{\gamma}}\right)^{\gamma}}{1+(1+r)^{-1}\frac{Y_{N,t+1}}{Y_{N,t}}\left(\frac{p_{N,t+1}^{II}}{p_{N,t-1}^{II}}\right)^{\frac{1-\alpha}{1-\theta}}}\right)^{-\frac{\alpha}{1-\alpha(1-\gamma)}} \cdot \\ &\cdot\left(\frac{P_{T,t-1}^{\gamma} + (1+r)^{-1}\frac{Y_{N,t}}{Y_{N,t-1}}\left(\frac{p_{N,t}^{I}}{p_{N,t-2}^{I}}\right)^{\frac{(1-\alpha)[1+(1+\gamma)(1-\theta)]}{(1-\theta)}} P_{T,t}^{\gamma}}{1+(1+r)^{-1}\frac{Y_{N,t}}{Y_{N,t-1}}\left(\frac{p_{N,t}^{I}}{p_{N,t-2}^{I}}\right)^{\frac{1-\alpha}{1-\theta}}}\right)^{-\frac{1-\alpha}{1-\alpha(1-\gamma)}}. \end{aligned} \tag{3.43}$$

In what follows, Proposition 2 will be reproduced in the above modeling framework with Taylor-pricing. Since the real exchange rate depends on lagged and future prices in a complex manner, real exchange rate dynamics are solved numerically.[22] The parameter values are chosen as follows: α, the fraction of firms setting prices in even periods, is set to equal 0.5. Following Mendoza and Uribe (1999b), γ, the share of tradables in total consumption, was set to 0.5. This is in line with Mexican and Brazilian data, where the weights of non-tradable goods in the CPI equal 0.6 (see Mendoza, 2000:6) and 0.46, respectively.[23] The value of $\theta = \frac{4}{5}$ is taken from Blanchard and Kiotaki (1987); the real interest rate $r = 6.5$ percent from King, Plosser and Rebelo (1988). The path of the nominal exchange rate is set such that the nominal devaluation in the aftermath of stabilization amounts to 30 percent. It is assumed that the implementation of the period t^* exchange rate reduction is publicly announced at the beginning of period $t^* - 1$, that is, price setters in period $t^* - 1$ are the first to take into account the future reduction and ensuing increase in the nominal exchange rate.

Given the exogenously assumed nominal exchange rate path, (relative) non-tradables' prices and the real exchange rate can be numerically solved. A graphic exposition of the exogenously imposed path of P_T and the resulting paths of P_N and the real exchange rate are presented in appendix 3.6.3 to this chapter; the implied rates of real appreciation are reported in table 3.1 (on page 116). They give evidence of a real exchange rate appreciation of almost 13 percent in the period preceding the peg's breakdown, followed in period $t^* + 1$ by a real depreciation of 16.66 percent. Thereafter, the real exchange rate converges quickly to its long-run value.

Of course, given the relatively simple modeling setup, these values are not fit for a direct comparison with actually observed dynamics during ERBS. This would require extending the model, for instance by a further endogenization of labor supply and production decisions and more sophisticated formulations of the consumption basket, exchange rate policy and the formation

[22]Note that $\frac{Y^e_{N,t+1}}{Y_{N,t}}$ is a function of $p^I_{N,t}$:

$$\frac{Y^e_{N,t+1}}{Y_{N,t}} = \frac{C^e_{N,t+1}}{C_{N,t}} = p_{N,t}^{\alpha(1-\gamma)} p_{N,t-1}^{(1-\alpha)\gamma} p_{N,t+1}^{-(1-\alpha)} p_{N,t+2}^{-\alpha(1-\gamma)} \left(\frac{P_{T,t}}{P_{T,t-1}}\right)^{\gamma}.$$

Due to the way the P_N enter the enumerators of the second and third terms of these equations, logarithmic versions of equations (3.42) and (3.43) cannot be solved analytically for $P_{N,t}$ or $\frac{P_{N,t}}{P_{T,t}}$ (nor be transformed into linear functions in non-tradables' prices).

[23]See Chapter 2.

Period	*Real Appreciation (-)/Depreciation Rate (in percent)*
$t^* - 1$	2.05
t^*	-12.98
$t^* + 1$	16.66
$t^* + 2$	-3.87
$t^* + 3$	0.40
$t^* + 3$	0.02
$t^* + 4$	0.001

Table 3.1: The real appreciation in the model with Taylor pricing

of exchange rate expectations.[24] Despite these caveats, the model's results are not too far from what has been witnessed during the Mexican ERBS which lasted from February 1988 to November 1994: During this program – which was followed by an annual devaluation rate of 90 percent – the real exchange rate appreciated by 32.6 percent.

3.4 Empirical Evidence on Forward-Looking Price Setting

The model developed in the previous sections presents an explanation for the real exchange rate dynamics prior to currency devaluation. This section looks to Mexican data to test if current non-tradables' prices actually incorporate expectations of nominal exchange rate depreciation. Mexico was chosen as a testing ground due to its history of failed exchange rate pegs and the availability of disaggregated monthly data on prices.

3.4.1 Exchange Rate Policy in Mexico

This section provides a short summary of exchange rate regimes implemented in Mexico from 1975 to 2000. This serves as the basis for classifying periods of 'managed' and 'flexible' exchange rate regimes in the empirical analysis. The account is based on Cardoso and Levy (1988), Dornbusch and Werner (1994), and the 1995, 1997 and 1999 OECD *Economic Surveys* of Mexico. I abstain from explaining why a certain monetary policy regime was implemented or abandoned. With respect to the later, the reader is referred to the extensive

[24]The consumption basket assumed here, for example, implies a unity elasticity of substitution between tradable and non-tradable goods, whereas empirical estimates find a value of about 1.3 (see Mendoza, 1995).

literature on the 1994 Mexican currency crisis, for example the survey by Calvo and Mendoza (1996) and the contributions in the May 1996 issue of the *American Economic Review*.

Since 1969, Mexico implemented two exchange rate pegs, each of which lasted for more than five years.[25] The first lasted from January 1969 to July 1976. Throughout this period, the peso/US dollar exchange rate (as reported in the OECD *Main Economic Indicators* database) was pegged at a level of 0.0125 pesos per US dollar. The peg was followed by a 60 percent devaluation of the Mexican peso in September 1976. After the crisis, the central bank quickly managed to stabilize the exchange rate without officially returning to a managed exchange rate regime. The period from March 1982 to November 1987 was characterized by high levels and volatility of the devaluation rate: The introduction of dual exchange rates in August 1982 could not prevent a 41 percent depreciation of the peso in September 1982. Major depreciations with monthly rates of 113, 18 and 21 percent occurred in January 1983, July 1985 and November 1987, respectively. In response to the foreign exchange market turbulences of November 1987, the peso was pegged to the US dollar: After an administrative devaluation of 38.9 percent in December 1987, the exchange rate was maintained at a level of 2297.50 pesos per US dollar (from February 1988 until January first of 1989). Thereafter, the fixed exchange rate was replaced by a crawling peg, a system of pre-announced currency depreciation. In November 1991, a fluctuation band was introduced, whose lower bound was widened at a pre-announced rate of 0.0002 pesos per day, equivalent to an annual devaluation rate of two percent, until October 1992 and 0.0004 pesos thereafter. The fluctuation band was thus gradually widened from 1.1 to 15 percentage points by the end of 1994. In December 1994, Mexico witnessed a major currency crisis: The crawling peg collapsed, and the peso devalued at a monthly rate of 38 percent. Since then, the official exchange-rate policy in Mexico is a commitment to a floating exchange rate, with occasional central bank interventions to decrease nominal exchange rate volatility.

Given this historical record, the periods from January 1969 to July 1976 and from February 1988 to November 1994 are classified as 'managed exchange rate regimes'[26]. Obviously, this classification can be debated – the Mexican authorities intervened heavily in the foreign exchange market during the first half of the eighties and monthly depreciation rates ranged from -1.45 to 5.7 percent during the 'managed exchange rate regime' from Febru-

[25] With that, Mexico has not exactly followed the pattern of chronic inflation countries, countries where high and persistent inflation rates motivated frequent stabilization attempts, as for example during the past four decades in Argentina, Brazil and Uruguay. Unfortunately, data on disaggregated prices is scarcely available for these economies.

[26] These are defined to include regimes of fixed exchange rates.

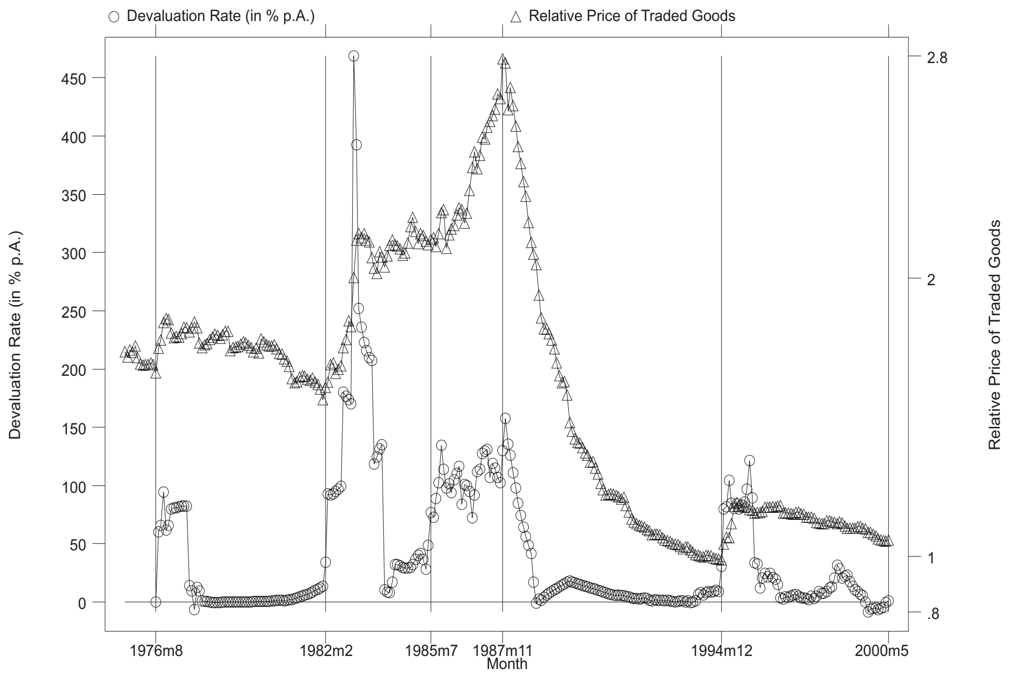

Figure 3.4: The relative price of tradable goods and the devaluation rate, August 1975 to May 2000

ary 1988 to November 1994. Despite these qualifications, the classification is broadly consistent with a data-based criterion for exchange rate stability: When considering all periods where the monthly devaluation rate is below one percent for at least six consecutive months, only the periods from March 1977 to April 1981 and from December 1995 to May 1996 are not contained in the above periods of managed exchange rates.

3.4.2 The Empirical Analysis

The empirical analysis is based on monthly data from August 1975 to May 2000. Data was obtained from the OECD *Main Economic Indicators* Database, the *International Financial Statistics*, the Central Bank of Mexico, the *Instituto Nacional de Estadística, Geographia e Informatica (INEGI)*, Mexico, the *Currency Forecasters Digest* publication and the *Bureau of Labor Statistics.* Appendix 3.6.4 provides a detailed description of the data.

Figure 3.4 presents the Mexican devaluation rate and the relative price of traded goods in Mexico. The latter is computed as the ratio of Mexican durables' and services' prices, both re-based such that the ratio equals 1 in

1994. The classification of durables as tradable goods and services as non-tradables is standard in the literature.[27] Mendoza (2000:3) reports it to be roughly consistent with a definition of tradable goods “as those pertaining to sectors for which the ratio of net exports to gross output exceeds 5 percent.” The relative price of traded goods is measured on the right axis, the annual devaluation rate (in percent) on the left axis. The vertical lines indicate “major exchange rate crises”, as identified by Osakwe and Schembri (1999). The major devaluations which occurred in August 1976 and in December 1994 mark the end of managed exchange rate regimes.

The data shows that relative tradables’ prices decrease (that is, non-tradables’ prices increase) preceding the collapse of managed exchange rate regimes and the pronounced devaluation rate increase which started in 1982. Price movements prior to the ‘Tequila Crisis’ in December 1994 are salient – the relative price of non-tradables increased by 170 percent during the managed exchange rate episode which lasted from February 1988 to December 1994. Under the assumption of perfect foresight, these price dynamics are consistent with the mechanism depicted in my model, that is, producers of non-tradables which raise prices in anticipation of the devaluation-induced increase in input costs.

From February 1982 to November 1987, however, repeated jumps of the devaluation rate which are *not* preceded by real appreciations can be observed. This period is generally characterized by high and volatile inflation and devaluation rates, presumably associated with considerable insecurity about monetary policy. During this period, the annual devaluation rate is characterized by a mean and a standard deviation of 108.4 and 80.1 percent, respectively, whereas the mean and standard deviation for the period from August 1975 to January 1982 amount to 13.6 and 27.5 percent, and to 20.7 and 32.2 percent during the period from December 1978 to May 2000. This suggests two possible explanations for the missing link between future devaluation rates and the relative price of tradable goods which are not incorporated in my model: First, contract length – and thus the degree of forward-orientation of prices – is likely to decrease as the magnitude and volatility of the overall price level rises. Second, a loss of forecast accuracy should be reflected in a weaker link between current relative non-tradables’ prices and the *observed* (forwarded) devaluation rate.[28] Using the Mexican-US nominal interest rate differential as the expected devaluation rate, the second hypothesis is confirmed: The correlation coefficient of the spread and the one-month ahead devaluation

[27]See the overview of the literature on real exchange rate decompositions summarized in the appendix to Chapter 2.

[28]These features are not present in my model, where non-tradables’ prices are *always* constant over two periods and agents are assumed to hold perfect foresight.

rate amounts to only 0.58 for the full sample from August 1975 to May 2000, but rises to a value of 0.83 when excluding the period from August 1976 to January 1988.

Devaluation rate expectations play a crucial role in this chapter's model. The above approximation with the nominal interest rate spread follows the literature.[29] The theoretical basis for this is international interest parity (IIP): Under perfect international capital mobility, dollar-denominated returns on Mexican and US assets with identical characteristics as regards to liquidity and riskiness should be equal: If an asset earns a higher real return, profit-maximizing international investors buy the assets, bidding up its price until its real return equals those of the other assets. The difference between Mexican and US interest rates can therefore be interpreted as the expected devaluation rate of the Mexican peso. It must be pointed out, however, that the assumptions underlying IIP are restrictive, and certainly not fulfilled by Mexican and US government debt, which is characterized by different riskiness and liquidity; moreover, perceptions of the bonds' riskiness, in particular, the Mexican government's probability to default have been subject to change over the period considered. Furthermore, high nominal interest rates might not always reflect expected devaluation rates, but sometimes the central bank's restrictive monetary policy stance, as for example when the Swedish central bank tried to fend off a currency crisis in 1992. In general, empirical assessments of IIP based on industrial country's nominal exchange rates give an ambiguous account of its validity: Most of the estimates surveyed in Froot and Thaler (1990) find that IIP does not hold; Chinn and Meredith (2002), in contrast, find that it tends to hold in the long run.[30] Frankel and Okongwu (1995), however, conclude, based on a sample of nine *emerging economies* (among them Mexico):

> "The largest single component of the gap [between Emerging Markets and US interest rates] is expectations of depreciation of the local currency against the dollar."

To assess the spread's predictive quality, figure 3.5 compares the Mexican-US interest rate spread and the annual 'forward devaluation rate', calculated from 1-month forward exchange rates for the limited periods where this data is available.[31] It shows that both measures follow the same *tendency*, even

[29] See for example Froot and Klemperer (1989), and Rose and Svensson (1995).

[30] An exposition of tests of covered and uncovered interest parity can be found in Cuthbertson (1996, Chapters 11 and 12).

[31] Monthly data on Mexican nominal interest rates – namely, the series on Banks' Average Cost of Funds provided by the Mexican Central Bank – is available from August

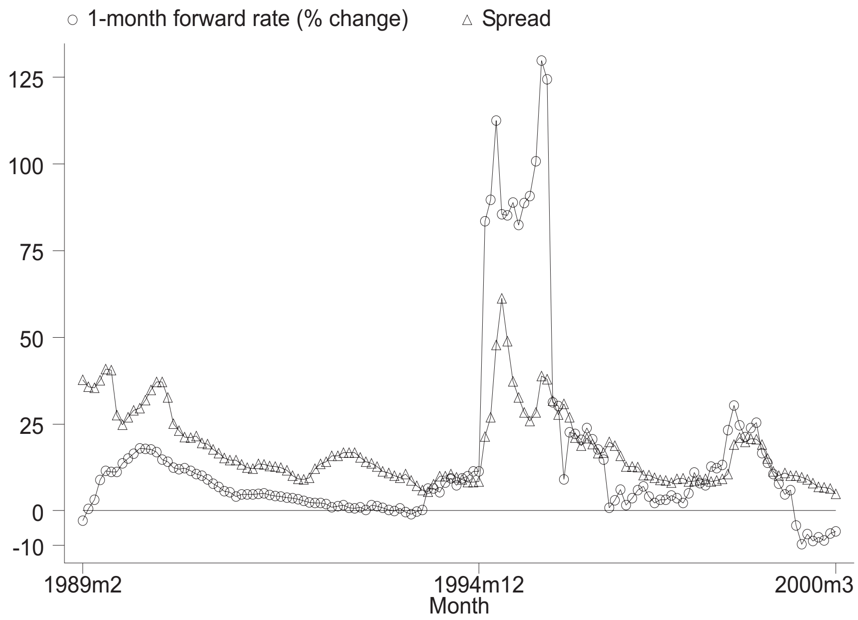

Figure 3.5: The spread and the annual devaluation rate implied by 1-month forward exchange rates, February 1989 to March 2000

though their absolute value differs substantially at times. The same holds true for survey-based one-month ahead exchange rate forecasts, which are almost identical to one-month forward rates.[32]

Besides the spread between Mexican and US government debt, alternative measures of devaluation rate expectations have been suggested by the literature. These include the interest rate differential on peso- and dollar-denominated liabilities of the Mexican government (see Agenòr and Masson, 1999), forward rates, survey-based forecasts, or estimates on the basis of economic fundamentals. However, data on the first three variables is not publicly available for the entire period under consideration here, and the latter produced counter-intuitive and barely significant results.[33] Therefore, I rely on

1975 onwards. Survey-based forecasts and one-month forward rates are from the *Currency Forecasters' Digest (CFD)*. My access to this data is limited to the period from January 1988 to March 2000. I am indebted to Menzie Chinn and Stefan Hubrich for granting access to their CFD data.

[32]The variables' correlation coefficient is 0.99 for the period from February 1988 to March 2000. As pointed out by the literature on the 'peso problem', forward exchange rates during exchange rate pegs frequently exhibit an (alleged) 'bias' as they might incorporate the possibility of a large devaluation (see Lewis, 1995).

[33]The regression results of the fundamentals-based estimations of devaluation rate expectations are available upon request.

	Full sample		*Managed Exchange Regimes*	
	Spread	1-M-Forward Rate	Spread	1-M-Forward Rate
1 month ahead	0.58	0.91	0.84	0.96
3 months ahead	0.53	0.72	0.87	0.87
6 months ahead	0.45	0.52	0.89	0.67
12 months ahead	0.22	-0.01	0.26	0.30
18 months ahead	0.10	-0.16	0.56	0.01
24 months ahead	0.03	-0.23	0.64	-0.26

Table 3.2: Correlations of the spread and the one-month forward rate with the actual devaluation rate

the interest rate differential to quantify devaluation rate expectations. In order to assess the accuracy of the different devaluation rate forecasts, table 3.2 presents correlation coefficients of the annual forward devaluation rate, calculated from one-month-forward rates, the spread and the actual (future) devaluation rate. It shows that the one-month forward rate is better at predicting the short run, whereas the spread performs better when forecasting at longer horizons. For instance, the correlation of the spread and the 18-month ahead devaluation rate is higher for both the full sample and for periods of managed exchange rates (see table 3.2). Assessing the accuracy of devaluation rate expectations during managed exchange rate regimes might appear futile, since these should consist in a pre-announced nominal exchange rate. Recall, however, that private agents' predictions have to account for the possibility of an abandonment of the current exchange rate regime. Furthermore – as reported in section 3.4.1 – the Mexican monetary authorities exercised some discretion during the most recent exchange rate peg.

The basic model introduced in section 3.2 assumed that non-tradables' prices must be held constant over two periods, that is, current prices only incorporate expectations of what happens one period ahead. What is the *empirically* 'correct' forecasting horizon, that is, how many months of expected future devaluation rates are reflected in current non-tradables' prices? Answering this question requires information about the duration of the (implicit) 'price contracts', a subject the empirical literature on high inflation economies is silent on. As a crude measure for price inertia, I calculate correlations of current prices and different lags of money growth, that is, growth of the monetary aggregate $M4$. This is meant to approximate the duration until an increase in $M4$ is reflected in higher prices, thus giving a notion about the degree of price stickiness.[34] The correlation coefficients presented in table 3.3

[34]This analysis ignores concerns about reverse causality.

Correlations of	CPI	Price of Durables	Price of Services
contemporaneous M4 growth	0.63	0.59	0.57
1-month lagged M4 growth	0.70	0.58	0.70
2-month lagged M4 growth	0.62	0.57	0.59
3-month lagged M4 growth	0.60	0.52	0.62
4-month lagged M4 growth	0.59	0.54	0.58
5-month lagged M4 growth	0.54	0.52	0.52
6-month lagged M4 growth	0.55	0.48	0.53
12-month lagged M4 growth	0.38	0.27	0.44
18-month lagged M4 growth	0.13	0.006	0.23
24-month lagged M4 growth	0.046	-0.14	0.20

Note: all variables transformed into monthly growth rates; data from January 1986 (earliest date for which monthly data on monetary aggregates is publicly available) to May 2000

Table 3.3: Correlation of the CPI, the prices of durables and the prices of services with (lagged) values of M4

confirm the model's assumption of excess sluggishness of non-tradables' over tradables' prices. Furthermore, the correlation coefficient of 0.2 between two-year lagged growth in $M4$ and non-tradables' prices suggests a high degree of persistence of non-tradables' price inertia.

To investigate the effect of an expected exchange rate depreciation on non-tradables' prices and the real exchange rate more closely, the differential of monthly growth in services' and durables' prices is regressed on the expected future depreciation rate of the Mexican peso. A significant positive relationship between these two variables can be interpreted as supporting my model, that is, the hypothesis that the relative increase in non-tradables' prices preceding currency crises results from forward-looking price setting. Regression specification is based on the model's pricing equation (3.42), which gives the price of non-tradable goods as a function of the expected devaluation rate, the current level of tradables' prices, lagged and future non-tradables' prices and lagged, current and future demand for non-tradable goods. The basic regression is

$$\left(\frac{\Delta P_N}{P_N} - \frac{\Delta P_T}{P_T}\right) = \text{constant} + \beta(\text{expected devaluation}) + \text{f(other determinants)}$$

where $\left(\frac{\Delta P_N}{P_N} - \frac{\Delta P_T}{P_T}\right)$ denotes the differential of services' and durables' prices and 'expected devaluation' the log of the spread. 'Other determinants' of $\left(\frac{\Delta P_N}{P_N} - \frac{\Delta P_T}{P_T}\right)$ suggested by equation (3.42) include variables reflecting the supply and demand of tradable and non-tradable goods, lagged and future values of $\left(\frac{\Delta P_N}{P_N} - \frac{\Delta P_T}{P_T}\right)$. Furthermore, goods prices in the US – Mexico's main trading partner[35] – the devaluation rate, lagged CPI, monetary variables and a trend variable were included in different specifications. All variables besides the spread were either transformed into monthly growth rates, or logs of first differences. To avoid spurious regressions, the differential of services' and durables' prices was tested for stationarity. The tests allowed to reject the null hypothesis of a unit root; detailed test results are reported in appendix 3.6.4.

Estimation results are presented in tables 3.4 to 3.6. Table 3.4 reports results based on the full sample from August 1975 to May 2000, with all variables except the spread transformed into monthly growth rates. Interacted dummies are included to differentiate between regimes of flexible and managed exchange rates. The regression results show that the spread's impact on relative non-tradables' prices is positive and significant only during periods of managed exchange rates. Therefore, the further estimates reported in tables 3.5 and 3.6 are based on samples which include only periods of managed exchange rates. The estimations in table 3.5 reproduce those reported in table 3.4 with data transformed in first-differenced logs (instead of monthly growth rates); Table 3.6 includes retail sales, which are publicly available only from January 1986 to March 2000, as an additional regressor. Three different specifications are presented in each table: Specification (I) is the 'base specification'; Specification (II) includes lagged endogenous variables, which yields biased, but asymptotically efficient and consistent results.[36] Specification (III) considers only regressors which proved to be significant at a level of at least 10 percent in the fully interacted estimations (I) and (II) reported in table 3.4. All estimations were performed with OLS, using Prais-Winsten (Prais and Winsten, 1954) transformed data whenever first-order serially-correlated residuals were detected.

The results indicate that the spread is one of the few robust determinants of relative non-tradables' prices during managed exchange rate regimes. The sign and significance of the expected devaluation rate's coefficient is robust to varying the exact specification and method of data transformation. Although

[35]In the year 2000, 84.3 percent of Mexican imports and 88.7 percent of its exports were from or to the USA.

[36]Furthermore, the Durbin-Watson statistic is biased towards 2. Therefore, I perform Durbin's h-test when lagged endogenous variables are included. The Durbin h-test regresses the OLS residuals on their own lags and the original regressor list. The coefficient on the lagged residual series, in ratio to its estimated standard error, is distributed 't' under the null of zero autocorrelation in the error process. This test is asymptotically equivalent to the original test proposed by Durbin, as discussed in Greene (1999, Chapter 13).

	(I) OLS	(II) Prais-Winsten	(III) Prais-Winsten
1-month-lagged $\left(\frac{\Delta P_N}{P_N} - \frac{\Delta P_T}{P_T}\right)$	–	0.25(3.29)**	0.25(3.11)**
1-m.-lagged $\left(\frac{\Delta P_N}{P_N} - \frac{\Delta P_T}{P_T}\right)$, mg. exr.	–	0.25(2.00)*	0.22(1.58)
Spread	0.23(1.45)	0.23(1.75)#	0.20(1.62)
Spread, mg. exr.	0.80(2.54)*	0.42(1.52)	0.46(1.73)#
Devaluation rate	-0.08(-6.46)**	-0.09(-6.72)**	-0.09(-7.48)**
Devaluation rate, managed exch.r.	-0.00(-0.02)	-0.04(-0.31)	
Lagged CPI	-0.18(-1.93)#	-0.14(-1.76)#	-0.11(-1.49)
Lagged CPI, managed exch.r.	0.22(1.64)	0.16(1.20)	
US durables' prices	-0.66(-2.20)*	-0.47(-1.73)#	-0.30(-1.41)
US durables' prices, manag. exch.r..	0.59(1.19)	0.62(1.32)	
US services' prices	0.91(2.30)*	0.71(2.07)*	0.62(2.25)*
US services' prices, managed exch.r.	0.22(0.37)	0.17(0.30)	
Manufacturing production	-0.02(-0.41)	-0.03(-0.83)	-0.06(-2.21)*
Manuf. prod., managed exch.r.	-0.02(-0.45)	-0.01(-0.24)	
Lag. manuf. prod.	-0.09(-2.10)**	-0.12(-2.48)*	
Lag. manuf. prod., manag. exch.r.	0.05(0.89)	0.07(1.18)	
Services production	0.15(1.40)	0.15(1.35)	0.15(1.37)
Services production, mg. exr.	-0.19(-1.35)	-0.25(-1.80)	-0.21(-1.69)#
Lag. services production	0.18(1.30)	0.12(0.95)	
Lag. services prod., man. exr.	-0.11(-0.66)	-0.01(-0.05)	
Exch.r-reg. dummy	-1.75(-1.95)#	-1.14(-1.49)	-0.77(-1.25)
Constant	-0.39(-0.82)	-0.36(-0.91)	-0.35(-1.01)
R^2	0.42	0.54	0.51
DW Statistic	1.94	2.08	2.08
Durbin's h	0.50		

Notes: Fully interacted regression to distinguish between regimes of managed and flexible exchange rates; 295 observations.

**, * and # indicate significance at a level of 1, 5 and 10 percent, respectively. Heteroscedasticity-consistent t-values are in parentheses. "Exch.r-reg. Dummy" denotes the exchange rate regime dummy, which equals one during periods of fixed exchange rate regimes and zero otherwise. All variables carrying the addition "mg. exr." ("managed exchange rate regimes") are interacted dummies, which capture a possible additional impact of the respective variable during managed exchange rate regimes. They are generated by multiplying the variable with the exchange rate regime dummy. "Lag." denotes one-month lagged values, "Manuf. prod." manufacturing production.

Table 3.4: Regressions for the full sample

	(I) Prais-Winsten	(II) OLS	(III) OLS
1-m.-lagged $\left(\frac{\Delta P_N}{P_N} - \frac{\Delta P_T}{P_T}\right)$		$0.31(3.22)^{**}$	$0.29(3.24)^{**}$
Spread	$0.01(4.50)^{**}$	$0.01(4.58)^{**}$	$0.01\ (4.76)^{**}$
Devaluation rate	-0.03(-0.26)	-0.07(-0.59)	-0.10(-0.80)
Lagged CPI	0.00(-1.27)	0.00(-0.37)	0.00(-0.40)
US durables' prices	-0.29(-0.64)	0.12(0.29)	0.28(0.69)
US services' prices	$1.25(2.87)^{**}$	$1.15(2.54)^{*}$	$1.06(2.37)^{*}$
Manufacturing prod.	-0.03(-1.14)	$-0.04(-1.75)^{\#}$	
Lag. man. prod.	$-0.03(-1.74)^{\#}$	$-0.04(-1.70)^{\#}$	-0.022(-0.79)
Services production	-0.11(-1.52)	-0.09(-1.11)	$-0.11(-3.81)^{**}$
Lag. services prod.	0.05(0.56)	0.09(1.11)	
Constant	$-0.02(-3.13)^{**}$	$-0.02(-3.79)^{**}$	$-0.02(-3.81)^{**}$
R^2	0.33	0.52	0.49
DW Statistic	1.83	1.76	1.74
Durbin's h		0.12	0.95

Notes: 91 observations. **, * and $^{\#}$ indicate significance at a level of 1, 5 and 10 percent, respectively. Heteroscedasticity-consistent t-values are in parentheses. '1-m.-lagged' denotes 1-month lagged variables

Table 3.5: Regressions with data in first-differenced logs, managed exchange rate regimes only

	(I) Prais-Winsten	(II) OLS	(III) OLS	(IV) OLS
1-m.-lagged $\left(\frac{\Delta P_N}{P_N} - \frac{\Delta P_T}{P_T}\right)$		0.36(3.94)**	0.38(4.36)**	0.36(3.89)**
Spread	1.06(2.60)**	0.68(2.24)*	0.63(2.13)*	0.63(2.14)*
Devaluation rate	0.02(0.15)	0.00(-0.01)	-0.04(-0.32)	-0.07(-0.59)
Lg. CPI	0.08(0.43)	0.23(1.67)$^{\#}$	0.24(1.86)$^{\#}$	0.23(1.71)$^{\#}$
US durables' prices	-0.40(-0.75)	0.17(0.32)	0.19(0.38)	-0.11(-0.23)
US services' prices	0.54(0.95)	0.27(0.46)	0.11(0.21)	0.59 (1.13)
Manufacturing production	0.03(-1.32)	-0.03(-1.42)		
Lag. man. prod.	-0.04(-2.02)*	-0.04(-1.75)$^{\#}$	-0.02(-0.94)	
Services production	-0.07(-0.85)	-0.09(-1.13)	-0.13(-1.71)$^{\#}$	
Lag. services prod.	0.03(0.36)	0.03(0.38)		
Retail sales	-0.01(-1.05)	-0.01(-0.55)	0.00(-0.15)	0.00 (-0.40)
Lag. retail sales	0.01(0.64)	0.02(1.43)	0.02(2.01)*	0.02 (1.89$^{\#}$)
Constant	-1.98(-2.01)*	-1.54(-2.22)*	-1.40(-2.09)*	-1.50 (-2.23*)
R^2	0.35	0.57	0.56	0.54
DW Statistic	1.86	1.94	1.94	1.95
Durbin's h		-0.34	-0.08	-0.05

Notes: 81 observations. **, * and $^{\#}$ indicate significance at a level of 1, 5 and 10 percent, respectively. Heteroscedasticity-consistent t-values are in parentheses.

Table 3.6: Regressions including retail sales, managed exchange rate regimes only

the coefficients' magnitude varies across specifications, the quantitative impact of an increase in expected devaluation does not change excessively: According to my minimum and maximum coefficient estimates, an expected 30 percent increase in the nominal exchange rate, for example, yields a 0.93 to 1.57 percent increase in the monthly growth rate of non-tradables' over tradables' prices.

The price setting mechanism implied by my model should – in theory – also hold for flexible exchange rate regimes. Two reasons why this cannot be found empirically are to be pointed out: First, nominal exchange rates might be harder to predict during flexible exchange rate regimes. Second, nominal exchange rate fluctuations and their impact on relative non-tradables' prices dwarf all other factors (see Mussa, 1986). The estimation result supports the latter hypothesis: The current devaluation rate is highly significant during periods of floating exchange rates, whereas it is not significant during managed exchange rate regimes. The same holds true for US prices of durables and of services.

The fact that the prices of services in the US are not significant when retail sales are included (see table 3.6) suggests that both variables might be capturing the effect of global economic tendencies. As pointed out in chapter 1, most explanations of the initial stylized facts of ERBS view the real exchange rate appreciation as a result of excess demand for non-tradable goods. Of the demand and supply indicators included in above regressions, only lagged manufacturing production turned out to have a significant effect on relative non-tradables' prices. Counter-intuitively, the effect is *negative*. This reflects the strong correlation of demand and supply: The correlation coefficient of durables consumption and manufacturing production, for example, is 0.98 (calculated with annual data from 1988 to 1993). Thus, the coefficient of manufacturing production might as well be interpreted as reflecting *demand* for traded goods.[37] The fact that the coefficient of lagged retail sales is positive and significant when only retail sales are included as an indicator for demand or supply (see estimation (IV) of table 3.6) suggests that the regressors' correlation might indeed blur results when including various variables capturing demand and supply.

A further important determinant of the growth rate of relative non-tradables' prices is their one-month lagged value. This is compatible with the staggered price setting discussed in section 3.3, which gives rise to a backward-looking

[37] Of course, this contradicts the model's assumption of PPP, which implies that the home economies' supply or demand for tradable goods should not affect their price. However, the coefficient value is sufficiently small (the maximum absolute value of 0.12 implies that a ten percent increase in manufacturing production cum demand yields decrease in relative non-tradables prices of 1.2%) to uphold PPP.

component in non-tradables' prices.

All of the above results are robust in the sense that the magnitude and significance of the regressors, in particular the spread, does not change substantially when including further explanatory variables, as the monetary aggregate $M4$, a linear trend variable, more lagged values of regressor variables (that is, lagged indicators of supply and demand, the CPI or the devaluation rate), or the endogenous variable.

These findings constitute evidence in favor of my model, which explains real exchange rate movements during fixed exchange rate regimes with producers of non-tradable goods who incorporate expectations of a future devaluation rate increase in their current prices. Nevertheless, economic models and their empirical verification can virtually always be criticized on the grounds of fundamental misspecification. Playing the devil's advocate, how could the positive correlation between the spread and the relative price of non-tradable goods be interpreted? If IIP did not hold, that is, the spread not reflect devaluation rate expectations, it could be interpreted as resulting from increased credit costs: Assuming the existence of a credit-in-advance constraint in the (monopolistic) production of non-tradable goods, an increase in credit costs is passed through on the price of non-tradable goods. This gives rise to a positive relation between the nominal interest rate differential and relative non-tradables' prices. However, the story is not plausible given the policy background of this chapter: The empirical evidence presented in Chapter 1 showed that the real appreciation during ERBS is accompanied by a credit *expansion,* a fact which renders increasing credit costs implausible.

To summarize, the empirical results show that an explanation of the real appreciation during temporary ERBS includes the following elements: (1) backward-looking relative non-tradables' prices, (2) increases in demand, and (3) forward-looking price setting in the sense that relative non-tradables' prices reflect expectations of a future devaluation.

3.5 Conclusions

This chapter offers an explanation for the real appreciation witnessed during transitory ERBS and in general prior to currency crises. In a model with monopolistic competition and sticky prices of non-tradable goods, producers' devaluation rate expectations are shown to contribute to the real appreciation preceding the collapse of an exchange rate peg. Empirical evidence for the existence of a positive relation between relative non-tradables' prices and the expected devaluation rate is then explored with monthly Mexican data. Using the Mexican-US interest rate differential as an indicator for devaluation rate expectations, OLS regressions confirm the model's price setting hypothesis: During managed exchange rate regimes, a rise in the spread is found to have a significant and positive impact on the relative price of non-tradable goods.

In the model presented here, the peg's breakdown originates from seignorage-financed government spending. Hence, it is warranted by fundamentals which are independent from the expectations-driven real exchange rate appreciation. However, as pointed out in the introduction to Chapter 2, the real exchange rate appreciation is frequently viewed to *cause* the peg's collapse: Policymakers might become concerned about the distortion arising from an overvalued real exchange rate, in particular the associated current account deficits.[38] The expectations-driven real exchange rate appreciation could thus *cause* a self-fulfilling currency crisis.

The next chapter presents a model in this spirit. There, sustained current account deficits cause the stabilization's self-fulfilling transitoriness.

[38]This chapter's model could be extended in this direction by introducing a quadratic government loss function which increases in the real appreciation rate (or current account deficits) and the devaluation rate.

3.6 Appendix

3.6.1 Deriving a Closed-Form Solution for Total Consumption Demand

A closed-form consumption function can be derived combining the first-order condition for optimal consumption and the intertemporal budget constraint. Leading the first-order condition and summing up yields

$$\sum_{s=t}^{\infty} C_s(1+r)^{t-s} = (1+\pi_t)C_t \sum_{s=t}^{\infty}(1+\pi_s)^{-1}(1+r)^{t-s}. \tag{3.44}$$

As agents do not hold initial assets, their intertemporal budget constraint can be reformulated to yield

$$\sum_{s=t}^{\infty}(1+r)^{t-s} C_s = \sum_{s=t}^{\infty}(1+r)^{t-s}\left[\frac{P_{T,s}}{P_s}\bar{y}_T + \frac{P_{N,s}}{P_s}Y_{N,s} + g_t - \frac{M_s - M_{s-1}}{P_s}\right]. \tag{3.45}$$

Inserting (3.44) into (3.45) allows to solve for C_t as

$$C_t = (1+\pi_t)^{-1}\left[\sum_{s=t}^{\infty}(1+\pi_s)^{-1}(1+r)^{t-s}\right]^{-1} W_t \tag{3.46}$$

where W_t is defined as $W_t \equiv \sum_{s=t}^{\infty}(1+r)^{t-s}\left(\frac{P_{T,s}}{P_s}\bar{Y}_T + \frac{P_{N,s}}{P_s}Y_{N,s} + g_t - \frac{M_s - M_{s-1}}{P_s}\right)$.

Note that a rise in inflation decreases contemporary consumption, whereas an increase in future inflation increases current consumption:

$$\frac{\partial C_t}{\partial \pi_t} = (-1)\left(1 + (1+\pi_t)\sum_{s=t}^{\infty}(1+\pi_s)^{-1}(1+r)^{t-s}\right)^{-2} \cdot$$
$$\cdot \sum(1+\pi_s)^{-1}(1+r)^{t-s}W_t + (1+\pi_t)^{-1}\sum_{s=t}^{\infty}(1+\pi_s)^{-1}(1+r)^{t-s-1}\frac{\partial W_t}{\partial \pi} < 0$$

$$\frac{\partial C_t}{\partial \pi_{t+1}} = (1+\pi_t)^{-1}(1+\pi_{t+1})^{-2}\left[\sum_{s=t}^{\infty}(1+\pi_s)^{-1}(1+r)^{t-s}\right]^{-2}(1+r)^{-1}W_t > 0$$

3.6.2 Deriving the Price of Intermediate Non-Tradable Goods from Producers' Profit Maximization

The price of each non-tradable intermediate good is constant over periods t and $t+1$. The present value of expected nominal profits over these periods accruing to the producer of an intermediate non-tradable good is given by

$$\sum_{j=0}^{1}(1+r)^{-j}\left[p_{N,t}(z)-P_{t+j}\ MC\right]y_{N,t+j}(z). \tag{3.47}$$

In setting their prices, the producers of non-tradable intermediate goods incorporate the effect on the demand for their respective good, given as

$$y_{N,t}(z)=\left(\frac{P_{N,t}}{p_{N,t}(z)}\right)^{\frac{1}{1-\theta}}Y_{N,t}. \tag{3.48}$$

Individual price setters ignore the effect of their prices on the aggregate price level and aggregate demand, that is, $\frac{\partial P_t}{\partial p_{N,t}(z)}=\frac{\partial P_N}{\partial p_N}=\frac{\partial Y_N}{\partial p_N}=0$. Maximizing above equation with respect to $p_{N,t}(z)$ yields the first-order condition

$$\sum_{j=0}^{1}(1+r)^{-j}\left[y_{N,t+j}(z)-\frac{1}{1-\theta}y_{N,t+j}(z)+\frac{1}{1-\theta}MC\ P_{t+j}y_{N,t+j}(z)p_{N,t}(z)^{-1}\right]. \tag{3.49}$$

Substituting $y_{N,t}(z)$ with the expression given by above equation and rearranging terms yields $p_{N,t}(z)$ as

$$p_{N,t}(z)=\theta^{-1}MC\frac{\sum_{j=0}^{1}\left\{(1+r)^{-j}P_{t+j}P_{N,t+j}^{\frac{1}{1-\theta}}Y_{N,t+j}\right\}}{\sum_{j=0}^{1}\left\{(1+r)^{-j}P_{N,t+j}^{\frac{1}{1-\theta}}Y_{N,t+j}\right\}}.$$

The above equation shows that all determinants of the individual producer's price depend on economy-wide uniform variables. Thus, all prices of intermediate non-tradable goods are equal, and – according to equation 3.15 – equal to the aggregate price level, $P_{N,t}=p_{N,t}(z)$. P_N is assumed to be constant over periods t and $t+1$,which simplifies above expression to yield

$$P_{N,t}=\theta^{-1}MC\frac{\sum_{j=0}^{1}(1+r)^{-j}P_{t+j}Y_{N,t+j}}{\sum_{j=0}^{1}(1+r)^{-j}Y_{N,t+j}}.$$

Substituting for P_t and P_{t+1} $\left(=\left(\frac{P_{T,t+1}}{\gamma}\right)^{\gamma}\left(\frac{P_{N,t+1}}{1-\gamma}\right)^{(1-\gamma)}\right)$ in above expression and setting $p_{N,t}(z)=P_{N,t}$ yields $p_{N,t}(z)$ as

$$P_{N,t}=\theta^{-\frac{1}{\gamma}}\gamma^{-1}(1-\gamma)^{1-\frac{1}{\gamma}}MC\left[\frac{P_{T,t}^{\gamma}+(1+r)^{-1}P_{T,t+1}^{\gamma}\frac{Y_{N,t+1}}{Y_{N,t}}}{1+(1+r)^{-1}\frac{Y_{N,t+1}}{Y_{N,t}}}\right]^{\frac{1}{\gamma}}. \tag{3.50}$$

Above equation yields $p_{N,t}(z)$ as a function of $Y_{N,t+1}$ and $Y_{N,t}$, which are considered exogenous by the individual price setter. Within the model, the output of non-tradable goods is of course endogenous: The assumption of demand- determined output implies that non-tradables output equals non-tradables consumption. Demand for non-tradables is given by $C_{N,t}=(1-\gamma)\frac{P_t}{P_{N,t}}C_t$. The first-order condition for optimal consumption yields $\frac{C_{t+1}}{C_t}=\frac{P_t}{P_{t+1}}\frac{P_t}{P_{t-1}}$. P_t was derived as $P_t=\left(\frac{P_{T,t}}{\gamma}\right)^{\gamma}\left(\frac{P_{N,t}}{1-\gamma}\right)^{(1-\gamma)}$. Using these equations, $\frac{Y_{N,t+1}}{Y_{N,t}}$ can be reformulated to yield

$$\begin{aligned}\frac{Y_{N,t+1}}{Y_{N,t}} &= \frac{P_{t+1}}{P_t}\frac{P_{N,t}}{P_{N,t+1}}\frac{C_{t+1}}{C_t}=\\ &= \frac{P_{N,t}}{P_{N,t+1}}\frac{P_t}{P_{t-1}}=\\ &= \frac{P_{N,t}}{P_{N,t+1}}\left(\frac{P_{N,t}}{P_{N,t-1}}\right)^{1-\gamma}\left(\frac{P_{T,t}}{P_{T,t-1}}\right)^{\gamma}=\\ &= P_{N,t}^{2-\gamma}P_{N,t+1}^{-1}P_{N,t-1}^{-(1-\gamma)}\left(\frac{P_{T,t}}{P_{T,t-1}}\right)^{\gamma}.\end{aligned}$$

Substituting this expression in the above equation for $P_{N,t}$ yields

$$P_{N,t}=\theta^{-\frac{1}{\gamma}}\gamma^{-1}(1-\gamma)^{1-\frac{1}{\gamma}}MC^{\frac{1}{\gamma}}P_{T,t}\left[\frac{1+(1+r)^{-1}\left(\frac{P_{T,t+1}}{P_{T,t}}\right)^{\gamma}\left(\frac{P_{T,t}}{P_{T,t-1}}\right)^{\gamma}\left(\frac{P_{N,t}}{P_{N,t+1}}\right)\left(\frac{P_{N,t}}{P_{N,t-1}}\right)^{1-\gamma}}{1+(1+r)^{-1}\left(\frac{P_{T,t}}{P_{T,t-1}}\right)^{\gamma}\left(\frac{P_{N,t}}{P_{N,t+1}}\right)\left(\frac{P_{N,t}}{P_{N,t-1}}\right)^{1-\gamma}}\right]^{\frac{1}{\gamma}}. \tag{3.51}$$

This equation cannot be solved analytically for $P_{N,t}$. However, an explicit solution for $P_{N,t}$ is not necessary to derive the real exchange rate and consumption movements during stabilization (see the proofs of Propositions 1 and 2).

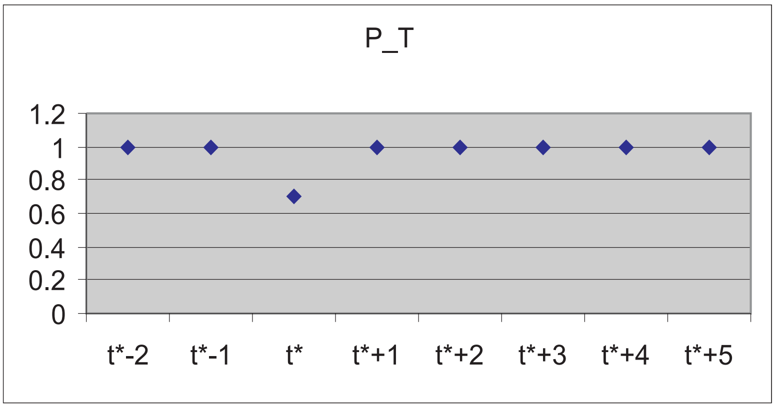

Figure 3.6: Tradables' prices in the model with Taylor pricing

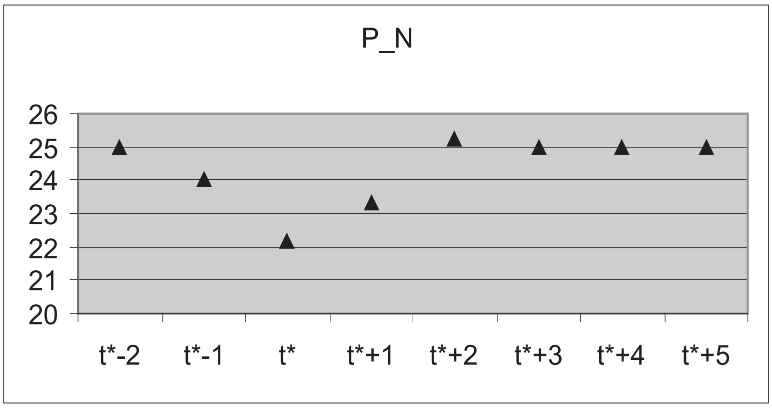

Figure 3.7: Non-tradables' prices in the model with Taylor pricing

3.6.3 The Paths of $P_{T,t}$, $P_{N,t}$, and the Real Devaluation Rate in the Model with Taylor Pricing

The path of P_T is set such that the nominal devaluation between periods t^* and $t^* + 1$ amounts to 30 percent. The values for P_N and the real exchange rate are then endogenously derived, under the assumption that P_N returns to its long run value in period $t^* + 4$. The 'Mathematica'-files used for the computation of P_N and the other endogenous variables are available upon request. The figures below present the exogenously assumed path of P_T, the resulting paths for non-tradables' prices and the real exchange rate.

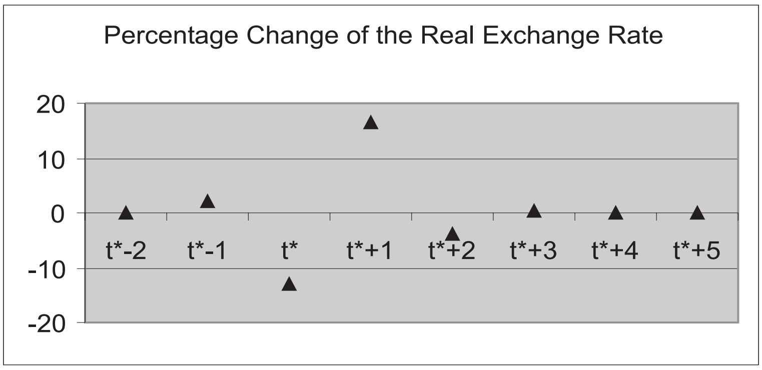

Figure 3.8: The real appreciation (-)/depreciation rate in the model with Taylor pricing

3.6.4 Appendix to the Empirical Section

Data

Mexican Data:

- Price of durable goods: Central Bank of Mexico ("Sector Precios, Bienes durables")
- Price of services: Central Bank of Mexico ("Sector Precios, Servicios")
- Interest rate: Banks' average cost of funds, Central Bank of Mexico
- 1 Month Forward Rate: The data is proprietary of the *Currency Forecasters Digest (CFD)* publication, various issues.
- Nominal Exchange Rate: OECD Main Economic Indicators (MEI), Line 437003D (Mexican pesos per US dollar, Monthly average)
- M4: Central Bank of Mexico
- CPI: OECD MEI, Line 435205K
- Manufacturing Production: Index of monthly level of manufacturing; Interpolated from annual data from the *Instituto Nacional de Estadística, Geographia e Informatica (INEGI)* until 1/80 (assuming a constant annual growth rate), thereafter monthly data from the OECD MEI, Line 432007K IIP

- Supply of services: Weighted average of supply of financial services and transport; Interpolated from annual data from the INEGI until 1/80 (assuming a constant annual growth rate), thereafter from quarterly data

US Data:

- Price of durable goods: CPI durable goods, OECD Main Economic Indicators, Line 425205K
- Price of services: Bureau of Labor Statistics, Urban CPI for services
- CPI: OECD, Main Economic Indicators
- Nominal interest rate: Bank prime Loan Rate (IFS: 60P)
(all price indices were re-based such that the average of all observations for 1994 equals 100)

Testing $\frac{\Delta P_N}{P_N} - \frac{\Delta P_T}{P_T}$ for Stationarity

Testing for stationarity of the endogenous variable in above regressions, $\left(\frac{\Delta P_N}{P_N} - \frac{\Delta P_T}{P_T}\right)$, the augmented Dickey-Fuller (ADF) and the Phillips-Perron tests were employed. Under the null, the time series contains a unit root. The decision criterion is to reject the null hypothesis if the absolute value of the standard t-statistic is greater than the absolute value of the critical values at some desired level of significance reported by Fuller (1976) and Perron (1988), respectively. In choosing the lag length for the lagged differences of $\left(\frac{\Delta P_N}{P_N} - \frac{\Delta P_T}{P_T}\right)$ in the ADF test regressions, Campbell and Perron's (1993) backward selection procedure was followed. It indicates an order of the estimated ADF regression of 14. The test results, based on 282 monthly observations, are reported in the following table:

	Test Statistic	McKinnon approx. p-val.
ADF with constant	-3.444	0.0095
ADF without constant	-3.359	n.a.
Phillips-Perron Test with constant	-11.989	0.0000
Phillips-Perron Test without constant	-11.949	n.a.

The null hypothesis of a unit root can be rejected at a 1 percent significance level. A trend variable proved to be not significant, and was therefore not included in above-reported regressions. Note that the caveats to unit root tests pointed out in section 2.3 apply.

Chapter 4

The Self-Fulfilling Temporariness of Exchange Rate-Based Stabilizations

4.1 Introduction

> *"Left unaddressed, however, was a more fundamental issue: To what extent did the crisis reflect genuine deficiencies in the Brazilian economy and to what degree was it a self-fulfilling prophecy?"*
>
> (The New York Times, May 23th, 1999, on the Brazilian currency crisis, which led to a 40 percent devaluation of the Brazilian currency in January 1999.)

This collapse of the Brazilian currency peg to the US dollar constitutes yet another example for the spectacular failures of ERBS. During the last three decades, Brazil alone implemented four different ERBS, none of which succeeded in permanently stabilizing Brazilian devaluation (and inflation) rates– between 1970 and 1994, Brazil added 12 zeroes to its price level. The average duration of the exchange rate pegs was 11 quarters. Figure 4.1 illustrates the typical 'rise and fall' during ERBS with data on the recent Brazilian stabilization, which was implemented in June 1994 and officially abandoned in January 1999.

The panels give evidence of an increase in consumption and GDP growth during the initial stages of stabilization. As the former exceeds the latter, the economy runs a current account deficit, which is financed with capital imports. These dynamics constitute part of the 'stylized facts' of ERBS, which have been discussed already in Chapter 1. An additional empirical regularity is

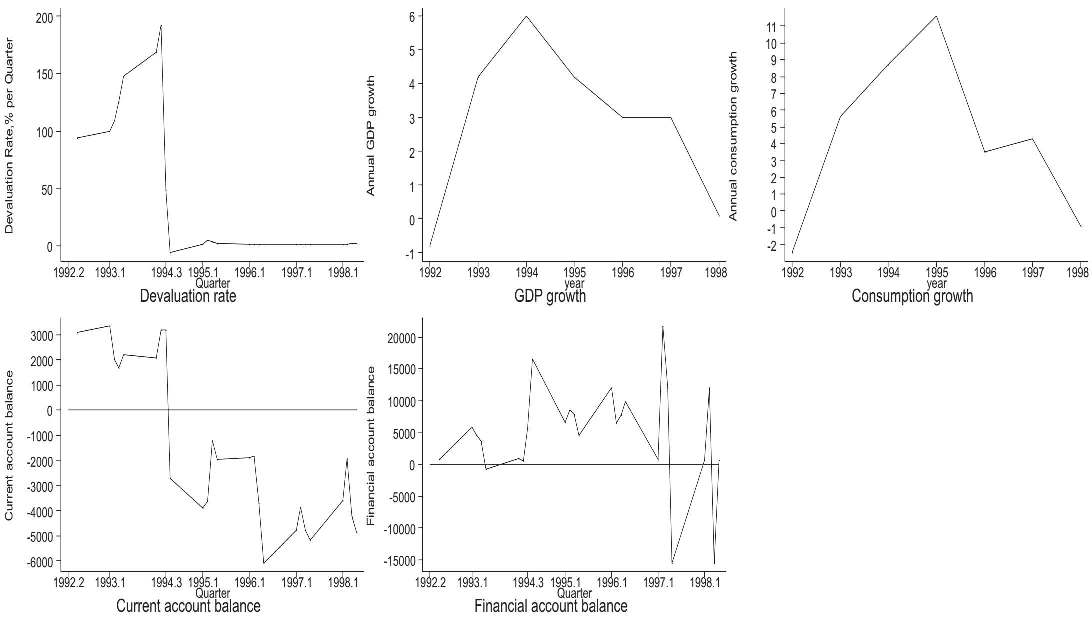

Figure 4.1: Dynamics during the 1994 ERBS in Brazil (Growth rates are expressed in percent per annum, the current and financial account balances in millions of US dollars (in 1995 prices)).

the programs' collapse: Almost half the episodes analyzed in the first chapter of this dissertation ended in a currency crisis within five years, 70 percent within ten years after their implementation. Further empirical evidence on the transitory nature of ERBS is provided by the extensive empirical literature on currency crises in developing economies.[1] The cyclical movements predating the collapse lead Reinhart and Végh (1995b:1) to conclude:

> "[T]he book of exchange rate-based stabilization in chronic inflation countries is filled with pages and pages of costly and spectacular failures. Successes are rare as a flawless diamond. Exchange rate-based stabilizations appear to lead to a dynamic adjustment which often carries the seeds of its own destruction."

What is this auto-destructive mechanism of ERBS? The literature on the initial effects of ERBS and the theories on currency crises are silent on possible *connections* between the two phenomena. Calvo and Végh (1999:1536) observe:

> "The literature, however, has had precious little to say so far about the possible links between the dynamics of exchange rate-based stabilizations and balance-of-payment crises. The Mexican crisis of December 1994 – which put an end to an exchange-rate-based stabilization plan initiated seven years earlier – brought back to life some of the key questions: Do exchange rate-based stabilizations sow the seeds of their own destruction by unleashing "unsustainable" real appreciations and current account deficits? Or are credibility problems and self-fulfilling prophecies at the root of these crises?"

This chapter tries to bridge this gap in the literature. It demonstrates that unsustainable current account deficits and credibility problems might not constitute *alternative* explanations for currency crises, as suggested by Calvo and Végh, but that deficient credibility might *cause* unsustainable current account deficits via consumption increases. Coupled with partial capital mobility, the current account deficits can bring about the peg's termination in a currency crisis. Thus, both the initial dynamics of ERBS and their transitoriness can be explained with self-fulfilling expectations about the duration of the peg.

This chapter proceeds as follows: Section 4.2 surveys the relevant literature on ERBS and on balance of payments crises. Section 4.3 informally

[1] See for example Kaminsky et al. (1998) for a survey of the literature, and Kamin and Babson (1999) for a recent contribution.

presents the model's intuition; section 4.4 introduces the formal modeling framework. Section 4.5 compares the real effects and sustainability of a credible and of a non-credible stabilization effort. Section 4.6 points out policy implications and a fruitful area for future research.

4.2 Survey of the Literature

This section presents a selective review of theories designed to explain the stylized facts of ERBS, and of models of self-fulfilling currency crises. As the theories have already been surveyed at length in section 1.5, only the approaches closest to the model presented in this section are pointed out, namely, those based on the perceived transitoriness of stabilization: When agents expect the devaluation rate reduction to be temporary, the consumption boom can be explained with (expected) intertemporal price changes (Calvo, 1986) or intergenerational wealth redistribution (Helpman and Razin, 1987). In these models, temporary stabilization is modeled as an exogenously given, perfectly anticipated temporary fall in the devaluation rate, which, via PPP, effects an equal reduction in the inflation rate. Government expenditure adjusts passively to redistribute the resulting seignorage revenues to the private sector. In an extension, Calvo (1987) endogenizes the devaluation rate path by incorporating Krugman's (1979) classic balance-of-payment crisis framework, in which the transitoriness of stabilization results from excessive domestic credit growth.

However, representative-agent models which exogenously assume temporary stabilization, or policies which render stabilization temporary, are not compatible with rational policy makers. From a welfare perspective, no stabilization, that is constant rates of inflation and currency devaluation, is preferable to temporary stabilization: Agents respond to inflation fluctuations by varying consumption. Given the decreasing marginal utility of consumption, this reduces overall utility, compared to an equilibrium with constant inflation and a flat consumption path.[2] Moreover, transitory ERBS cannot be interpreted as the result of a time-inconsistent policy, that is, a policy which gives the policymaker an incentive to discontinue the policy once private agents believe in it and act accordingly.[3] Time inconsistency can explain temporary inflation stabilization only if the policymaker has an incentive to return

[2]This assumes that inflation itself is not associated with negative welfare effects.

[3]Obstfeld and Rogoff (1996:389) define the problem of dynamic inconsistency in policymaking as follows: "[A] future policy that the government finds optimal today, taking account of its influence over the actions of others, may no longer be optimal once those actions have been taken."

to inflation when agents believe in permanently lower inflation rates, as in the seminal models by Kydland and Prescott (1977) and Barro and Gordon (1983). A crucial element of models of temporary ERBS, however, is that private agents fully *anticipate* the short-lived nature of stabilization – this anticipation is exactly why they increase consumption during the low-inflation period. Thus, the ensuing increase in inflation and devaluation rates cannot be interpreted as 'cheating' on private agents.

The implementation of temporary stabilization policies can be motivated when giving up the representative-agent assumption: Helpman and Razin (1987) propose an OLG model in which the current generation benefits from temporary stabilization at the expense of future generations. As the current generation votes, current policymakers have an incentive to favor them over future generations. Alfaro (1999) shows that policymakers might implement temporary ERBS to boost electoral outcomes by increasing the welfare of the owners of non-tradable goods.

A different answer to the question of why policy makers implement transitory stabilizations is offered by models of *self-fulfilling* currency crises. In these, policymakers *intend* stabilization to be permanent; its actual duration, however, is endogenously determined by private agents' arbitrary expectations. The pioneering work in this field is due to Obstfeld (1986), who shows that expectations of expansionary monetary policy in the aftermath of stabilization can lead to an instantaneous fall in money demand and increase in currency devaluation. However, as the other theories on currency crises, this model ignores the full dynamics preceding the collapse.[4]

4.3 Overview of the Model

Models on the stylized facts of ERBS simply *assume* stabilization to be temporary, while models which *explain* why stabilizations collapse, ignore what happens at the inception of stabilization. The framework presented in this chapter offers a joint explanation of both features of ERBS.

What is the mechanism? Intertemporal consumption substitution in response to expected intertemporal price changes is combined with credit rationing on international capital markets: Similar to Calvo (1986), consumption and output are subject to cash-in-advance constraints. Therefore, inflation stabilization implies a decrease of effective consumer goods' prices and production costs. If agents believe that the stabilization effort will be *tem-*

[4]Further models of self-fulfilling currency crises have been proposed by Dellas and Stockman (1989), Obstfeld (1994, 1996), and Cole and Kehoe (1996). A synthesis is presented by Jeanne (1995).

porary, they substitute consumption, and, to a smaller extent, production intertemporally into the low-inflation period. Due to imperfections in international capital markets, the resulting current account deficits can only be partially financed with capital imports: International investors are willing to supply credit only if private domestic agents' net foreign indebtedness is below a specific exogenously given fraction of their economy's GDP. Once the maximum level of foreign debt is reached, goods imports and the associated demand for foreign currency lead to a gradual depletion of central bank foreign currency reserves, which eventually culminates in the stabilization's collapse. As the government spending rule entails seignorage finance after the breakdown, devaluation and inflation rates rise, validating ex post agents' devaluation expectations. If, on the other hand, agents consider stabilization to be credible and associated with *permanently* lower inflation and devaluation rates, consumption remains constant and is entirely financed with period income. As no foreign debt is incurred, the peg can be upheld indefinitely. Thus, arbitrary expectations about the program's duration prove to be self-fulfilling.

Partial international capital mobility plays an important role in the analysis presented in this chapter. My model abstracts from explaining *why* constraints on international borrowing exist, but explores the *effects* of their existence in the analysis of ERBS. Given this focus, financial frictions are not formally derived as features of an optimal credit contract, but introduced by a simple aggregate borrowing constraint which imposes an upper limit on the ratio of net foreign debt to GDP. As pointed out in section 1.6, formulation is compatible with theories on borrowing under imperfect contract enforcement and with the empirical evidence on developing economies. Similar financial constraints have been incorporated in models on emerging economies by Cohen and Sachs (1986) and Mendoza (2001). The cessation of capital inflows above a particular debt-to-GDP ratio can either be interpreted as resulting from international creditors' behavior, in particular the collateralization of loans, or as reflecting official restrictions on international borrowing: In a (counterproductive) effort to prevent a crisis, the government might impose capital controls once foreign indebtedness reaches a certain level of GDP. The halt of capital inflows then brings about the crisis.[5]

[5]This argument follows Dellas and Stockman (1989), who propose a model where agents' expectations of capital controls cause currency crises.

4.4 The Model

Consider an economy which is populated with identical, infinitely-lived private agents and a government, which consists of a monetary and a fiscal branch. Private agents consume and produce a single traded good. In absence of impediments to trade, purchasing power parity holds, which – coupled with the assumption of constant prices abroad – implies that domestic inflation and devaluation rates are equal. Agents must hold real balances both for consuming and producing. The government's fiscal and monetary branches are not separated, meaning that the monetary branch is required to monetize the government's net transfers to the private sector whenever necessary.

4.4.1 The Private Sector

The representative private agent chooses his paths of consumption and production as to maximize the following utility function:

$$\int_0^\infty \left(\frac{1}{\left(1-\frac{1}{\sigma}\right)} c_t^{1-\frac{1}{\sigma}} - \frac{\kappa}{2} y_t^2 \right) e^{-\beta t}\, dt \tag{4.1}$$

c denotes consumption of a homogeneous good which is produced both at home and abroad, y output, σ the constant intertemporal elasticity of substitution ($0 < \sigma < 1$) and κ a positive constant. In order to eliminate inessential dynamics, β, the agent's subjective rate of time preference, is assumed to equal the real world interest rate, r. Output enters the utility function in order to capture the disutility the agent experiences when producing output. As shown by Obstfeld and Rogoff (1996:662), this formulation can be derived assuming the disutility of labor l as $-\Phi l$, and a production function of $y = A\ l^{\frac{1}{2}}$. Solving the production function for l yields $l = \left(\frac{y}{A}\right)^2$. Setting $\kappa \equiv \frac{\Phi}{A^2}$ yields the second term in equation (4.1). Without a loss of generality, the number of agents is assumed to equal unity.

The agent faces cash-in-advance constraints on consumption and output, that is, he has to cover at least a fraction α of total consumer expenditure and a fraction ν of production with cash holdings.

$$m_t^{np} \geq \alpha c_t \tag{4.2}$$

$$m_t^{p} \geq \nu y_t \tag{4.3}$$

where m^{np} denotes money held for non-productive purposes and m^p money held for productive purposes, and α and ν are constants which satisfy $0 <$

$\alpha \leq 1$ and $0 < \nu \leq 1$.[6] The rationale for the cash-in-advance constraint on consumption has been explored already in section 3.2.1. The cash-in-advance constraint on output can be interpreted as a cash-in-advance constraint on wage payments (which are not explicitly modeled): Based on the above-assumed production function and equality of wages and the marginal product of labor, the wage bill amounts to wl=0.5 $A\, l^{\frac{1}{2}}$; the cash-in-advance constraint requires $m_t^p \geq \nu y_t = \nu A\, l^{\frac{1}{2}}$, and thus implies that at least a fraction of 2ν of the wage bill must be held in cash.[7]

Total real balances, m, are given by the sum of money held for productive and non-productive purposes:

$$m_t = m_t^{np} + m_t^p \tag{4.4}$$

The agent faces the following intertemporal budget constraint:

$$E_0 + \int_0^\infty (y_t + g_t)e^{-rt}\, dt = \int_0^\infty (c_t + i_t\,(m_t^{np} + m_t^p))e^{-rt}\, dt \tag{4.5}$$

where E_0 denotes the agent's initial endowment; g and i real government net lump-sum transfers to the private sector and the nominal interest rate, respectively. The intertemporal budget constraint states that the sum of the present value of the agent's lifetime income and his initial wealth must equal the present value of his expenditure. The terms $i_t m_t^p$ and $i_t m_t^{np}$ capture the opportunity cost of holding money, that is, the interest income forgone, rm, and the capital loss inflation inflicts on holders of money, πm. The nominal interest rate is given by Fischer Parity as

$$i_t = r + \pi_t^e \tag{4.6}$$

where π_t^e denotes the expected inflation rate, which, in this model of perfect foresight, equals the actual inflation rate. r denotes the (constant) real international interest rate.

Restricting attention to equilibria where the nominal interest rate is positive, the cash-in-advance constraints will always hold with equality. This allows to reformulate the intertemporal budget constraint as

$$E_0 + \int_0^\infty (y_t(1 - \nu i_t) + g_t)e^{-rt}\, dt = \int_0^\infty c_t(1 + \alpha i_t)e^{-rt}\, dt.$$

Assuming no barriers to international trade, the price of the consumption good, expressed in a common currency, is equal across the domestic and the

[6]Similar cash-in-advance contraints on consumption and output have been used in recent papers by Schmitt-Grohé and Uribe.

[7]In which case ν must be restricted to $0 < \nu \leq 0.5$.

foreign economy. Combined with the assumption of constant prices abroad, purchasing power parity (PPP) implies that

$$\pi_t = \varepsilon_t \tag{4.7}$$

where π_t denotes the domestic inflation rate and ε_t the devaluation rate.

As pointed out in the introduction, the economy is characterized by imperfect capital mobility: International creditors halt credit supply when the private sector's net foreign assets fall below a critical value $\tilde{b}_t^* < 0$, defined to equal the negative of a certain fraction of GDP. The constraint on international borrowing requires

$$b_{p,t}^* \geq \tilde{b}_t^* \equiv -ny_t \tag{4.8}$$

where $b_{p,t}^*$ denotes the private sector's net foreign assets and n is a positive constant. It is assumed that the domestic agent considers the critical value $\tilde{b}_t^*$ to be exogenous.

As long as the borrowing constraint is not binding, the evolution of private wealth is given by

$$\dot{a} = ra_t + y(1 - \nu i_t) - c(1 + \alpha i_t) + g_t \tag{4.9}$$

where a denotes the agent's wealth. Equation (4.9) states that the agent's wealth increases when his period income, that is, output, interest income and net government transfers, exceeds period expenditure, which includes the cost of holding money. Wealth consists of holdings of money, the initial endowment, home ($b_{p,t}$) and foreign bonds ($b_{p,t}^*$).

$$a_t \equiv m_t + b_{p,t}^* + b_{p,t} + E_0 \tag{4.10}$$

Foreign assets are foreign currency-denominated. As PPP holds, it is admissable to suppress the nominal exchange rate, since changes in the nominal exchange rate or domestic prices do not affect the assets' real value.[8] Note that the initial endowment E_0 is stated as a separate element of the agent's wealth, as this renders analytical derivations in the following easier to trace. It will be shown shortly how the initial endowment is invested. Solving equation (4.10) for $b_{p,t}^*$ and replacing m_t $(= m_t^{np} + m_t^p)$ with the expressions implied by the cash-in-advance constraints yields the private sector's net foreign assets as

$$b_{p,t}^* \equiv a_t - (\alpha c_t + \nu y_t) - b_{p,t} - E_0$$

[8]This can be shown as follows: Let $b_{p,t}^{*,nom}$ denote nominal net foreign assets at the foreign price level. Real home-currency denominated bonds are given as $(S_t\ b_{p,t}^{*,nom})/P$, where S denotes the nominal exchange rate and P the home price level. Given PPP with foreign prices normalized to 1, $S_t = P_t$ and $b_{p,t}^{*,nom} = b_{p,t}^*$.

Thus, the constraint on international borrowing can be rewritten as

$$a_t - (\alpha c_t + \nu y_t) - b_{p,t} - E_0 \geq \tilde{b}_t^*. \tag{4.11}$$

The agent's optimization problem consists in choosing the paths for consumption and output which maximize his intertemporal utility, subject to his budget constraint, equation (4.9), and the constraint on international borrowing given by equation (4.11). Formally, the agent's optimal consumption and production decisions are derived by maximizing the following Hamiltonian function:[9]

$$\begin{aligned} H &= \{\frac{1}{\left(1-\frac{1}{\sigma}\right)} c_t^{1-\frac{1}{\sigma}} - \frac{\kappa}{2} y_t^2 + \lambda_t \left[r a_t + y(1-\nu i_t) - c(1+\alpha i_t) + g_t\right] - \\ & -\mu_t \left[\tilde{b}_t^* - a_t + (\alpha c_t + \nu y_t) + b_{p,t} + E_0\right] \} e^{-\beta t} \end{aligned} \tag{4.12}$$

where λ denotes the costate variable associated with the agent's budget constraint and μ the Lagrange multiplier associated with constraint (4.11). The static first-order conditions are given by

$$c_t^{-1/\sigma} = \lambda_t(1 + \alpha i_t) + \mu_t \alpha \tag{4.13}$$

and

$$\kappa y_t = \lambda(1 - \nu i_t) - \mu_t \nu; \tag{4.14}$$

the dynamic first-order condition by

$$\dot{\lambda}_t = \lambda_t(\beta - r) - \mu_t. \tag{4.15}$$

The complementary slackness condition requires that

$$\mu_t \geq 0 \ \mu_t \left[\tilde{b}_t^* - a_t + (\alpha c_t + \nu y_t) + b_{p,t} + E_0\right] = 0. \tag{4.16}$$

It is assumed that the usual transversality conditions hold.

Condition (4.13) equates the marginal utility of consumption, $c_t^{-1/\sigma}$, to the sum of two terms: The first term is the cost of consumption when the borrowing constraint is not binding. It consists of the output cost of 1 plus the opportunity cost of money held per unit of consumption, αi_t, multiplied with the marginal utility of wealth at the optimum, λ_t. The second term captures the shadow cost of consuming implied by the borrowing constraint: Increasing

[9]See Turnovsky (1997) for applications of dynamic control to open economies and Kamien and Schwartz (1991) for a general treatment of optimal control problems with inequality constraints.

consumption by one unit must be associated with an increase in money holdings by α, which is valorized with the multiplier associated with constraint (4.11), μ. The Lagrange multiplier μ can be interpreted as the shadow value of the international borrowing constraint, that is, as the increase in maximized utility that would occur if the constraint was to be eased marginally. First-order condition (4.14) states that at the optimum, the marginal disutility of producing output must equal the marginal utility generated by the additional unit of output. To see this, the first-order-condition is reformulated to yield

$$\kappa y_t = \lambda_t - \nu \left(\lambda_t i_t + \mu_t \right).$$

κy_t is the marginal disutility of producing output; the right hand side states the marginal utility derived from the additional output unit. It is lower than the marginal utility of income, λ, since the output increase must be accompanied by an increase in money holdings of ν units. This implies an opportunity cost of νi_t and a tightening of the wealth constraint, as, ceteris paribus, increased money holdings imply less holdings of foreign assets.[10]

In all periods where the borrowing constraint does not bind, the dynamic first-order condition boils down to

$$\dot{\lambda}_t = \lambda_t(\beta - r) \tag{4.17}$$

which, given the assumption that $\beta = r$, implies that λ is constant.

Finally, condition (4.16) states that μ_t equals zero whenever the borrowing constraint is not binding. How can this be interpreted? For some optimal c and y, the inequality might be tight, for some not. When it is not tight, it can be ignored and the corresponding shadow value is zero. When the borrowing constraint is binding, it can be treated as an equality, as in standard Lagrangian optimization.

4.4.2 The Government

The government consists of two branches: One is a fiscal branch that pays out a net transfer to the private sector according to an exogenous spending rule. The other is the central bank. It has two tasks: During regimes of fixed exchange rates, it must intervene in the foreign exchange market as necessary to defend the exchange rate. Its second task is to issue money to finance the net transfers whenever required by the fiscal branch. When these two tasks are conflicting, the latter takes precedence.

[10] Recall that the agent views $\tilde{b}_p^*$ as exogenous, that is, he does not consider the effect of increased output on the debt ceiling.

Exchange Rate Policy and Reserve Dynamics

The nominal exchange rate can be regarded as the relative price of the foreign currency: It states how many units of home currency must be paid in order to acquire one unit of the foreign currency.[11] The relative price of the foreign currency is determined by the relative demand for and the relative supply of it. In our model, demand for foreign currency is equal to the demand for imported goods and capital, both of which are denominated in foreign currency.[12] Foreign currency is supplied when foreigners buy domestic goods and assets. Furthermore, the central bank can intervene in the foreign exchange market and either increase demand for foreign currency by changing domestic into foreign currency, or expand supply by selling its foreign currency reserves against domestic currency. During a fixed exchange rate regime, the central bank has to supply exactly the amount of home or of foreign currency such that the foreign exchange market clears at the targeted nominal exchange rate. The frequency and type of central bank intervention is thus determined by the private sector's demand for and supply of the foreign currency. In case of excess demand for foreign currency, the central bank can intervene only as long as its reserves exceed a lower bound denoted R_{min}. A currency crisis is defined to occur when private investors acquire the stock of central bank foreign currency reserves up to R_{min} and the exchange rate devalues. Put differently, the exchange rate peg can be maintained in every period t in which

$$b^*_{CB,t} > R_{min} \tag{4.18}$$

holds, where $b^*_{CB,t}$ denotes the level of foreign-currency denominated bonds held by the central bank. It is assumed that the central bank's initial reserves, $b^*_{CB,0}$, have been acquired with means borrowed from the private sector in period zero, that is, $b^*_{CB,0} = E_0$. The interest earned on reserve holdings is transferred to the private sector as interest payment on E_0.

In general, the level of R_{min} depends on the central bank's willingness to defend the peg, and its ability to incur foreign debt. In this model, where the central bank cannot borrow abroad and does not dispose of own initial wealth, R_{min} is equal to zero.

[11] This is based on a nominal exchange rate expressed in 'European terms'.

[12] The cash-in-advance constraint on consumption assumes that both the consumption of domestic and of imported goods must be covered with *home* currency. It is assumed that agents can convert this currency into foreign currency and spend it without delay on foreign goods and assets.

Fiscal Policy

The government's net transfer to the private sector is determined by the following spending rule:

$$g_t = max[0, h(\bar{y} - c_t)] \tag{4.19}$$

where h denotes a positive constant and $\bar{y}$ the agent's permanent income, defined as the constant stream of period incomes whose present value is equal to the present value of the actual income stream:

$$\int_0^\infty \bar{y} e^{-rt} dt \equiv E_0 + \int_0^\infty y_t e^{-rt} dt$$

This yields permanent income as

$$\bar{y} = \left[r \left(\int_0^\infty y_t e^{-rt} dt + E_0 \right) \right] \tag{4.20}$$

where I have used the fact that $\int_0^\infty \bar{y} e^{-rt} dt = \bar{y} \int_0^\infty e^{-rt} dt = \bar{y} r^{-1}$. Equation (4.19) states that no net transfers are payed out when consumption is greater than or equal to permanent income, and positive transfers when consumption falls short of permanent income. This can be rationalized as the government's attempt to minimize demand fluctuations (by imposing taxes on c when $c > \bar{y}$, and granting transfers when $c < \bar{y}$) which is undermined by tax evasion, such that effectively, above spending rule emerges. Alternatively, the government spending rule (4.19) could be replaced by a government spending function which increases in the inflation rate, since the further analysis will show that government expenditure is positive when the inflation rate is high, and zero when prices are constant. This accords with the empirically observed negative correlation between inflation and tax revenues.[13]

To finance the transfer, the fiscal authority can either issue debt (held by the domestic private agent) or use the central bank's proceeds of money creation. I assume that these proceeds are transferred directly to the fiscal authorities. In reality, the fiscal branch issues debt to finance expenditure. The central bank then monetizes the debt by issuing money and using the proceeds to buy the debt. As shown in appendix 4.7.1 to this chapter, the net effect on the government's consolidated budget constraint is identical to assuming central bank revenues to be directly transferred to the fiscal authority.

[13]The negative correlation has been explained with tax collection lags (the so-called Tanzi Effect, see Tanzi, 1989) and increasing tax evasion as the inflation rate rises (Crane and Nourzad, 1986).

The government period budget constraint is given by[14]

$$g_t = \dot{m}_t + \varepsilon_t m_t + \dot{b}_{p,t} - r b_{p,t} \tag{4.21}$$

and its intertemporal budget constraint by

$$\int_0^\infty g_t e^{-rt}\,dt = \int_0^\infty (\dot{m} + \varepsilon m) e^{-rt}\,dt. \tag{4.22}$$

where I have used the transversality condition that $\lim_{T\to\infty} e^{-rT}\lambda_T b_{p,T} = 0$.

The economy-wide consolidated period budget constraint can be derived by substituting (4.21) in equation (4.9). This yields

$$\dot{b}^*_{p,t} = r\left(b^*_{p,t} + E_{0,t}\right) + y_t - c_t - \dot{E}_{0,t}. \tag{4.23}$$

The economy-wide intertemporal budget constraint can be derived as

$$E_0 + \int_0^\infty y_t e^{-rt}\,dt = \int_0^\infty c_t e^{-rt}\,dt \tag{4.24}$$

where I have used the transversality conditions that $\lim_{T\to\infty} e^{-rT}\lambda_T b^*_{p,T} = 0$ and $\lim_{T\to\infty} e^{-rT}\lambda_T E_{0,T} = 0$. Equation (4.24) shows that monetary variables do not enter the consolidated intertemporal budget constraint: The existence of money or the magnitude of inflation do not affect the economy's wealth. This follows from the assumption that all proceeds from seignorage are fully redistributed to the private sector.

4.4.3 The Money Market

Money demand is given by the cash-in-advance constraints: Recall that the agent holds a fraction α of consumption and a fraction ν of output in cash:

$$m_t = m_t^{np} + m_t^p = \alpha c_t + \nu y_t \tag{4.25}$$

Money market equilibrium implies that

$$\dot{m}^s = \alpha\dot{c} + \nu\dot{y} \tag{4.26}$$

where m^s denotes real money supply. As elaborated above, money supply is determined by the government's financing needs.

[14]This assumes that m does not jump, as proceeds from discrete changes in m (Δm) are neglected.

4.5 Stabilization

4.5.1 Defining Equilibria

Before proceeding to analyze the effects of ERBS under different expectational regimes, the model is clarified by summarizing the respective equilibrium conditions for an economy under fixed and under flexible exchange rates.

Definition 1 *In an equilibrium with a fixed exchange rate*
(P.1.) The representative agent follows his optimal consumption and production paths: First-order-conditions (4.13) and (4.14) are fulfilled for all t.
(P.2.) The private agent's and the government's budget constraints hold.
(P.3.) Either
(a) the reserve constraint (4.18) holds or
(b) the exchange rate remains constant, that is, the devaluation rate remains at zero without central bank intervention.
(P.4.) Money supply is such that the money market is balanced, that is, equation (4.26) holds.
(P.5.) Rational expectations hold. The expected devaluation rate equals actual future devaluation.
(P.6.) The constraint on international borrowing holds, that is, the level of net foreign assets exceeds $\tilde{b}_t^*$ for all t.

Definition 2 *In an equilibrium with a flexible exchange rate*
(F.1.) The representative agent follows his optimal consumption and production paths: First-order-conditions (4.13) and (4.14) are fulfilled for all t.
(F.2.) The private sector's and the government's budget constraints hold.
(F.3.) The devaluation rate is such that the money market is balanced, that is, equation (4.26) holds.
(F.4.) Rational expectations hold. The expected devaluation rate equals actual future devaluation.
(F.5.) The constraint on international borrowing holds, that is, the level of net foreign assets exceeds $\tilde{b}_t^*$ for all t.

The following differences between the equilibria with fixed and those with flexible exchange rates can be pointed out: Under fixed exchange rates, the central bank must assure that the money market is in equilibrium at the targeted devaluation rate, that is, it must adjust money supply such that it equals money demand at $\varepsilon = \bar{\varepsilon} = 0$:

$$g_t - \bar{\varepsilon} m_t - \dot{b}_{p,t} + r b_{p,t} = \alpha \dot{c} + \nu \dot{y}.$$

Under flexible exchange rates, in contrast, the devaluation rate (which, due to PPP, equals the inflation rate) adjusts until the money market is in equilibrium. As retained in condition (P.2), the fixed exchange rate can only be upheld if either the equilibrium exchange rate resulting from private agent's demand and supply of currency is equal to the targeted level, or if the central bank disposes of sufficient foreign currency reserves to intervene in the foreign exchange market such that the targeted exchange rate results.

The ensuing two sections analyze the real effects and the sustainability of ERBS. It will be shown that the implementation of an exchange rate peg can result in two different equilibria: If the peg is considered credible, that is, if the public expects the devaluation rate to remain permanently at zero, consumption and income remain at their steady state levels and the peg will be sustainable. If, on the other hand, the public expects the peg to be temporary and followed by an increase in the devaluation rate, consumption rises in excess of income during the peg, central bank reserves are eventually exhausted and the peg fails. Thus, expectations about the program's duration – which are exogenous ex ante – prove to be self-fulfilling.

4.5.2 Credible, Permanent Stabilization

Permanent stabilization consists of setting the devaluation rate permanently to zero, starting in period 0. The agent believes that stabilization will be permanent and sets his devaluation expectations accordingly. Setting $\varepsilon_t^e = 0$ for all t, the first-order conditions for optimal consumption and production are given by:

$$c_t^{-1/\sigma} = \lambda(1 + \alpha r) + \mu_t \alpha \tag{4.27}$$

$$\kappa y_t = \lambda(1 - \nu r) - \mu_t \nu \tag{4.28}$$

$$\dot{\lambda} = \lambda(\beta - r) - \mu_t \tag{4.29}$$

$$\mu_t \geq 0 \quad , \qquad \mu_t \left[a_t - \alpha c_t - \nu y - b_{p,t} - \tilde{b}_t^* \right] = 0 \tag{4.30}$$

It was assumed that the agent does not hold any initial foreign assets, that is, the constraint on international borrowing is not binding at the inception of stabilization and $\mu_0 = 0$. The values of the other μ_t, $t > 0$, depend on consumption and output. Equation (4.30) shows that their values, inter alia, determine if the borrowing constraint becomes binding and μ positive. The paths of c and y, however, can only be assessed when the value of μ_t is known. Therefore, I will first *assume* that μ_t equals zero, and then show that the paths of c and y actually are such that $\mu_t = 0 \;\forall\; t$ arises endogenously.

If $\mu = 0$, that is, if the constraint on international borrowing is not binding during credible stabilization, c and y are constant and given by their first-order-conditions as

$$c^{-1/\sigma} = \lambda(1 + \alpha r)$$

and

$$\kappa y = \lambda(1 - \nu r).$$

Given that consumption and output are constant, the consolidated intertemporal budget constraint allows to derive period consumption as

$$c = y + rE_0$$

where I have used the fact that $\int_0^\infty e^{-rt}\, dt = r^{-1}$. The above equation shows that in each period the agent's consumption equals his period income. No foreign assets or liabilities are incurred and the constraint on international borrowing never becomes binding:[15]

$$b^*_{p,t} = 0 > \tilde{b}^*_t \equiv -ny_t \;\forall\; t$$

The initial assumption of $\mu = 0$, which was used to derive the paths of consumption and production, is confirmed, and condition (P.6) for a fixed exchange rate equilibrium holds.

Conditions (P.1) to (P.5) are fulfilled, too: The agent follows his optimal consumption and production paths, respecting his budget constraint (condition P.1). Money market equilibrium requires real money supply to be constant at the level of money demand, $(\alpha c + \nu y)$, which – coupled with the zero devaluation rate – implies that no seignorage revenue is collected (condition P.4). This is compatible with the government budget constraint, since no transfers are paid when consumption equals permanent income (condition P.2). The nominal exchange rate remains constant without central bank intervention (condition P.3). Finally, the agent's belief that stabilization is credible and permanent is compatible with rational expectations, as a permanent fixed exchange rate equilibrium is indeed feasible (condition P.5).

4.5.3 Non-Credible, Temporary Stabilization

As in the previous section, stabilization policy involves setting the devaluation rate to zero in period 0. However, now the private agent expects this policy to be upheld only temporarily, that is, for T^* periods and followed by a floating

[15] Recall that the private agent does not hold any initial foreign assets ($b^*_{p,0} = 0$).

exchange rate regime with a positive devaluation rate thereafter. Formally, these devaluation rate expectations can be described as:

$$\begin{aligned} \varepsilon_t^e &= \varepsilon_I^e = 0 \text{ for } 0 \leq t \leq T^* \\ \varepsilon_t^e &= \varepsilon_{II}^e > 0 \text{ for } t > T^* \end{aligned} \tag{4.31}$$

In what follows, the period from zero to T^* will be called 'stabilization interval' and from T^* to infinity the 'post-stabilization interval'.

As long as the borrowing constraint is not binding, the first-order condition (4.13) indicates that consumption is constant over $[0, T^*]$ at a level denoted as c_I, and constant over $]T^*, \infty[$ at a level denoted c_{II}. The optimal consumption path is characterized by the following equation:

$$c_{II}(1 + \alpha(r + \varepsilon_{II}^e))^\sigma = c_I(1 + \alpha r)^\sigma \tag{4.32}$$

The optimal path of GDP is given by

$$y_{II}(1 - \nu r) = y_I(1 - \nu(r + \varepsilon_{II}^e)) \tag{4.33}$$

where y_I and y_{II} denote period GDP during the stabilization and post-stabilization interval, respectively. The above equations show that both consumption and output exceed their post-stabilization values during temporary stabilization – as $\varepsilon_{II}^e > 0$, $c_I > c_{II}$ and $y_I > y_{II}$. The sign and magnitude of the change in the consumption-to-GDP ratio cannot be determined analytically. However, for realistic parameter values (see appendix 4.7.3), the inflation reduction generates a consumption increase in excess of output. This is retained in assumption 1:

(A1) $\alpha, \nu, \sigma, r,$ *and* ε_{II}^e *are such that period consumption in the post-stabilization interval decreases more than output, relative to their respective values during the stabilization-interval :* $\frac{c_I}{y_I} > \frac{c_{II}}{y_{II}}$, that is, $\frac{(1+\alpha(r+\varepsilon_{II}^e))^\sigma}{(1+\alpha r)^\sigma} > \frac{1-\nu r}{1-\nu(r+\varepsilon_{II}^e)}$.

This assumption ensures that the agent's intertemporal substitution of consumption exceeds his intertemporal substitution of production. In addition to output, the agent receives interest income on his initial wealth holdings, such that his total period income during the stabilization-interval equals $(y_I + rE_0)$. In order to assess if the domestic agent incurs foreign debt during the stabilization-interval, the magnitude of consumption relative to period income must be considered. In what follows, it will be shown that c_I exceeds period income, which implies that a fraction of consumption is financed with imported capital. The procedure is based on a 'proof by contradiction': I will show that setting c_I equal to or below period income conflicts with what is retained in assumption $(A1)$. Consequently, assumption $(A1)$ implies that period consumption exceeds period income during the stabilization-interval.

In a first step, it is assumed that consumption equals income in each period, that is,

$$c_I = y_I + rE_0$$

and

$$c_{II} = y_{II} + rE_0.$$

Under this assumption, the ratio of consumption during the stabilization and the post-stabilization interval is given as

$$\frac{c_I}{c_{II}} = \frac{y_I + rE_0}{y_{II} + rE_0} = \frac{y_I}{y_{II}} \left(\frac{1 + y_I^{-1} rE_0}{1 + y_{II}^{-1} rE_0} \right).$$

The last term of the above expression, $\left(\frac{1+y_I^{-1}rE_0}{1+y_{II}^{-1}rE_0}\right)$ is smaller than one (by first order condition (4.14), $y_I^{-1} < y_{II}^{-1}$), contradicting assumption $(A1)$, in particular its implication that $\frac{c_I}{c_{II}}$ exceeds $\frac{y_I}{y_{II}}$. Similarly, $(A1)$ is violated if c_I is below period income $y_I + rE_0$: If the agent consumes less than his period income during the stabilization-interval, his intertemporal budget constraint implies that period consumption exceeds period income during the post-stabilization interval, that is, $c_{II} > y_{II} + rE_0$. Now, c_I is smaller and c_{II} greater than assumed in the first step of the derivation, and their ratio, $\frac{c_I}{c_{II}}$, smaller, which implies that, again, $\frac{c_I}{c_{II}}$ is smaller than $\frac{y_I}{y_{II}}$. This violates assumption $(A1)$.

Thus, assumption $(A1)$ implies that period consumption exceeds period income during the stabilization-interval, and that a fraction of consumption is financed with imported capital. Recall that this consumption profile can be interpreted as the agent's optimal response to intertemporal changes in consumption costs: The agent lifts his consumption in periods where the inflation rate is low – and consumption relatively less expensive – and incurs debt to finance the transitory consumption increase. When consuming becomes dearer (in the post-stabilization interval), the agent lowers consumption and pays back the debt.

What does this imply for government spending during the stabilization interval? The government spending rule (4.22) states that net transfers are zero if consumption exceeds permanent income. In the framework of non-credible stabilization, the present value of permanent income can be expressed as

$$\int_0^\infty \bar{y} e^{-rt} dt \equiv E_0 + \int_0^{T^*} y_I e^{-rt} dt + \int_{T^*}^\infty y_{II} e^{-rt} dt.$$

This allows to solve for $\bar{y}$ as

$$\begin{aligned}\bar{y} &\equiv r\left[E_0 + y_I\int_0^{T^*} e^{-rt}dt + y_{II}\int_{T^*}^{\infty} e^{-rt}dt\right] = \\ &= rE_0 + y_I - (y_I - y_{II})\, e^{-rT^*},\end{aligned}$$

which shows that period income $rE_0 + y_I$ exceeds permanent income during the stabilization interval, as by first-order condition (4.14), $y_I - y_{II} > 0$. This implies that period consumption exceeds permanent income during the stabilization interval. No transfers are payed out and the government does not issue debt nor money, that is, $\dot{m}_t = \dot{b}_{p,t} = 0$.

In a next step, the net foreign asset dynamics resulting from above consumption and output paths are analyzed. Substituting $g_t = \dot{m}_t = \dot{b}_{p,t} = b_{p,0} = 0$ into the agent's period budget constraint yields the private agent's foreign asset dynamics during the stabilization interval as

$$\dot{b}^*_{p,t} = r\left(b^*_{p,t} + E_0\right) + y_I - c_I - \dot{E}_0. \tag{4.34}$$

The above equation states that the home agent's net foreign assets holdings increase if his income, that is, production and interest income, exceeds consumption, or if he sells (part of) his endowment to buy foreign bonds.

In a first step, it will be considered how foreign assets evolve as long as the constraint on international borrowing is not binding. For these periods, the change in private net foreign assets is given by

$$\dot{b}^*_{p,t} = r(b^*_{p,t} + b^*_{CB,0}) + y_I - c_I. \tag{4.35}$$

Since the demand for foreign currency is satisfied with capital imports, central bank reserves are constant at their initial level of $b^*_{CB,0}$, which, by definition, is equal to E_0. The international borrowing constraint is defined in terms of the *level* of private net foreign assets. Therefore, the above differential equation must be solved for $b^*_{p,t}$ in order to derive if and when the constraint becomes binding. This solution yields[16]

$$b^*_{p,T} = \int_0^T (y_I - c_I + rE_0)e^{rt}dt. \tag{4.36}$$

$y_I - c_I + rE_0$ is negative as the agent substitutes consumption into the low-inflation period. A part of domestic demand is satisfied with imported goods, which are financed with capital imports. What does this imply for the foreign

[16] A detailed derivation of the solution is presented in the appendix 4.7.2 to this chapter.

exchange market? As long as imports of goods and capital are of equal magnitude, the exchange rate remains constant: The demand for foreign currency associated with goods imports is matched with supply of foreign currency via capital imports, and the equilibrium 'price' on the foreign exchange market – the exchange rate – does not move. As in each period, the private agent incurs foreign debt, his total foreign liabilities approach the critical level of $\tilde{b}_t^*$. Once this is reached, in a period I denote with T^{**}, capital inflows cease and the central bank has to supply foreign currency in order to meet demand – which still arises from goods imports – at the posted exchange rate. The change in central bank reserves in some period $T \in [0, \infty[$ is given by

$$\dot{b}_{CB,T}^* = y_I - c_I + r(b_{CB,T}^* + \tilde{b}_{p,T^{**}}^*),$$

that is, by the sum of the trade balance deficit $(y_I - c_I)$ and net capital imports. The level of central bank reserves can be solved for as

$$b_{CB,T}^* = \left[b_{CB,0}^* + \int_{T^{**}}^{T} (y_I - c_I + r\tilde{b}_{T^{**}}^*) e^{r(t-T)} dt \right] e^{r(T-T^{**})} \tag{4.37}$$

where T^{**} denotes the period in which capital inflows cease. A detailed derivation of this solution of the differential equation for $\dot{b}_{CB,T}^*$ is presented in appendix 4.7.2. Equation (4.37) shows that central bank reserves will eventually be exhausted. Furthermore, I have shown that consumption exceeds income as long as the devaluation rate remains at zero, that is, $y_I - c_I + r\tilde{b}_{T^{**}}^* < 0$. The demand of imported goods is associated with demand for foreign currency. Thus, in each period, the central bank must supply foreign currency in order to prevent a devaluation. As its initial reserves, $b_{CB,0}^*$, are finite, central bank reserves will eventually reach the level $R_{min} = 0$ in a period I denote with T^*. To recapitulate, table 4.1 states what happens in the model up to period T^*.

Thus far, I have shown that reserves reach their minimum level if agents expect stabilization to be temporary, that is, after period T^* the central bank can no longer intervene in the foreign exchange market. What does this imply for the exchange rate peg? To answer this question, nominal exchange rate dynamics succeeding T^* must be assessed. The nominal exchange rate is determined by demand for and supply of foreign relative to domestic currency. The private sector's demand for foreign currency equals its current account balance less its borrowing from abroad. In periods following T^*, the current account exhibits a surplus: As the agent expects an increase in devaluation (and inflation) rates in period T^*, he lowers consumption to the level c_{II} and production to y_{II}.[17] As retained in assumption (*A1*), consumption decreases

[17] This is shown by the first-order conditions (4.32) and (4.33).

Periods	Description
$0 < t < T^{**}$	$\varepsilon = \pi = 0$ $c = c_I$ and $y = y_I$ high, $c_I > y_I$ $g = 0$ Current account deficit financed with *capital imports*
in T^{**}	capital imports cease
$T^{**} \leq t < T^{*}$	$\varepsilon = \pi = 0$ $c = c_I$ and $y = y_I$ high, $c_I > y_I$ $g = 0$ Current account deficits engender loss of *central bank foreign currency reserves*

Table 4.1: The timing in the model

by more than output, such that $c_{II} < y_{II}$. The proceeds derived from goods exports are used to pay back the foreign debt incurred prior to period T^*. In short, the domestic agent exports both goods, associated with demand for domestic currency, and capital, which is associated with demand for foreign currency. Thus, the private agent's international transactions do not effect changes in the nominal exchange rate. This, however, does not hold true for the public sector's actions: Its spending requirements can only be met if devaluation and inflation rates are positive in the aftermath of period T^*: The government spending rule (4.19) requires positive net transfers to be payed out whenever consumption falls short of permanent income. This is the case in the post-stabilization interval, where agents reduce their consumption to c_{II} in expectation of a devaluation rate increase: Assumption ($A1$) implies that $c_{II} < y_{II}$, and y_{II} must be smaller than permanent income in order to fulfill the agent's intertemporal budget constraint. Therefore, $c_{II} < \bar{y}$. Since the government transfer is financed with seignorage, inflation and devaluation rates rise: The government budget constraint during the post-stabilization intervals is given as

$$h(\bar{y} - c_{II}) = \dot{m}_t + \varepsilon_t m_t + \dot{b}_{p,t} - r b_{p,t}. \tag{4.38}$$

Net government transfers – which are given by the left hand side of the above equation – are greater than zero. They must be financed with seignorage or government debt, held by the private agent. The latter is not feasible during the post-stabilization interval, where the private agent pays back his foreign debt and is not willing to acquire new debt. Since real money demand is constant at the level $(\alpha c_{II} + \nu y_{II})$, an equilibrium on the money market requires real money supply to be constant ($\dot{m} = 0$). Thus, inflation or devaluation tax proceeds ($\varepsilon_t m_t$) are the only feasible source of government revenue. Setting $\dot{m} = \dot{b}_{p,t} = rb_{p,t} = 0$ and solving the government budget constraint for the post-stabilization devaluation rate yields

$$\varepsilon_{II} = \frac{h(\bar{y} - c_{II})}{\alpha c_{II} + \nu y_{II}}. \tag{4.39}$$

As $\bar{y} > c_{II}$, this equation evinces that the post-stabilization devaluation rate is greater than zero. The agent's ex ante arbitrary expectation of a currency devaluation, as retained in equation (4.31), turns out to be true. Condition (P.3) for a fixed exchange rate regime is violated: The central bank's reserve constraint (4.18) fails to hold, and the exchange rate does not remain constant, but devalues in absence of central bank intervention.

Both the reserve depletion and the post-stabilization devaluation rate increase ultimately result from the agent's arbitrary belief that the peg will be temporary: His expectation of a devaluation rate increase induces him to consume more than his income, giving rise to the current account deficits and accumulation of foreign debt which are at the root of the peg's breakdown. Thus, the agent's expectations prove to be self-fulfilling.

The remainder of this section discusses some of the model's assumptions and possible extensions, with the aim of further clarifying how the model works. Furthermore, some assumptions which might appear restrictive at first sight can be shown to be easily modifiable without altering the model's main results.

First, the subject of foreign borrowing is addressed. The first-order condition (4.16) shows that the shadow value of foreign borrowing, μ, which enters the first-order conditions for optimal consumption and production, assumes a positive value when the constraint on foreign borrowing is binding. The reason why μ could be ignored in the above assessment of consumption and output dynamics is that the foreign borrowing constraint never becomes binding: When the critical level of foreign indebtedness is approached, agents switch from foreign borrowing to running down their initial endowment (and central bank foreign currency reserves) in order to finance consumption in excess of income. As can be seen by means of equation (4.34), $\dot{E}_0 < 0$ allows the agent to consume in excess of his period income without incurring foreign debt. In period T^*, the initial endowment is exhausted and the constraint on international borrowing would become binding if the agent upheld his level of consumption in the following periods. However, as the devaluation and inflation rates rise, period consumption is reduced below period income, which implies that the private agent does not *want* to borrow abroad, but starts paying back his foreign debt.

Another assumption which might require some more explanation is the constant real interest rate r. How can it be that the domestic real interest rate is constant even when the domestic economy is locked out from international asset markets? The answer to this question lies in the fact that the domestic private agent can always fulfill his optimal consumption and output plans, despite the constraint on international borrowing. As pointed out above, when capital inflows cease in period T^*, agents start running down their initial endowment, implying that no excess demand for credit arises. When the agent's initial wealth is exhausted, financing further current account deficits would indeed bid up the price of credit, that is, the interest rate. However, this coincides with the peg's collapse and a devaluation rate increase. As the latter effects a reversal of the current account balance, domestic agents do not demand foreign credit and domestic interest rates remain constant.

The constraint on international borrowing used in this model imposes a ceiling on foreign borrowing by the *private* sector. Additionally, it is assumed that debt issued by the domestic fiscal authority is held exclusively by the domestic agent. One might suspect that the self-fulfilling breakdown of ERBS could be prevented if the fiscal authority was allowed to borrow abroad. This is not the case: Assuming a fiscal authority which can borrow abroad coupled with an upper ceiling on the economy's *total* foreign debt would not change the model's results: The fiscal authorities need to pay transfers – and thus generate revenue – only in the post-stabilization interval. At the beginning of this interval, the international borrowing constraint is binding already due to the agent's foreign indebtedness. Therefore, the initial government transfer must necessarily be financed with seignorage.

4.6 Conclusions

This chapter shows that both the consumption boom following ERBS and the transitory nature of many stabilizations can be explained with self-fulfilling expectations about the peg's duration. With that, the model presents a possible link between the initial dynamics of ERBS and balance-of-payment crises.

What conclusions can be drawn from this? The empirical literature on the real effects of inflation stabilization typically regards the expansion during ERBS as a *virtue* of stabilization. The model here, however, shows that this judgement might be a fallacy: The consumption boom accompanying ERBS might be an indicator of the peg's deficient credibility, and thus a sign of the program's failure.

A policymaker committed to permanent stabilization could, by restraining consumption, both lower reserve losses and signal his determination to uphold the peg. One measure for reducing consumption consists in rising its cost. This can, for instance, be achieved by increasing credit costs via restrictions on capital inflows, a measure which has been gaining support in light of the East Asian crisis (Bhagwati, 1998 and Rodrik, 1998). My model, however, also points to a more fundamental issue: To avoid self-fulfilling currency crises, a policymaker needs to convince the public *ex ante* of his determination to follow an anti-inflationary stance. Therefore, a better understanding of how agents assess the credibility of a stabilization effort should yield valuable assistance for the design of effective stabilization policies.

4.7 Appendix

4.7.1 Deriving the Consolidated Government Budget Constraint

To clarify the linkage between the central bank's and the fiscal authority's accounts, the analysis in the following explicitly spells out both authorities' budget constraints. The analysis contained in the body of this paper presented both constraints in a consolidated manner: The government budget constraint, equation (4.22), assumes that seignorage revenues are transferred directly from the central bank to the government's fiscal branch. In most economies, the fiscal and the monetary branches of government are separated. To realize seignorage finance, the fiscal authority issues debt, which is then bought by the central bank with newly printed money. In this setting, the budget constraint of the fiscal authority is given as

$$\dot{b}_{p,t} + \dot{b}_{CB,t} = g_t + r\left(b_{p,t} + b_{CB,t}\right) \tag{4.40}$$

where $b_{CB,t}$ denotes liabilities of the fiscal authority which are held by the central bank. The above equation shows that net transfers g and interest payments on debt held by either the private sector ($b_{p,t}$) or the central bank ($b_{CB,t}$) are financed by issuing new bonds.

The balance sheet of my model's central bank can be summarized as follows:

Assets	**Liabilities**
Foreign bonds (=foreign currency reserves) $\left(b^*_{CB,t}\right)$	Currency in circulation (m_t)
Domestic bonds, issued by the fiscal authority ($b_{CB,t}$)	Indebtedness towards the private sector ($E_{0,t}$)

The period change in central bank assets can be expressed as:

$$\dot{b}^*_{CB,t} + \dot{b}_{CB,t} = r\left(b^*_{CB,t} + b_{CB,t}\right) + \dot{m} + \varepsilon_t m_t + \dot{E}_{0,t} - rE_{0,t} \tag{4.41}$$

The consolidated budget constraint of the fiscal and the monetary branches of government can be derived by solving equation (4.40) for $\dot{b}_{CB,t}$ and substituting the resulting expression into equation (4.41), and using the fact that, by assumption, $E_{0,t}$ equals $b^*_{CB,t}$. This yields

$$\dot{b}_{p,t} + \dot{m} + \varepsilon_t m_t = g_t + rb_{p,t}$$

which is the consolidated government budget constraint (4.21) used in the body of this chapter.

4.7.2 Foreign Assets and Reserve Dynamics

Equation (4.9) gives the change in the private agent's wealth as

$$\dot{m}_t + \dot{b}^*_{p,t} + \dot{b}_{p,t} + \dot{E}_{0,t} = y_t + g_t + r(b^*_{p,t} + E_{0,t} + b_{p,t}) - c_t - \varepsilon^e_t m_t \tag{4.42}$$

where I have used Fisher parity, that is, $i_t = r + \varepsilon^e_t$.

Substituting the government's budget constraint, equation (4.21), into the above equation yields aggregate foreign asset dynamics as

$$\dot{b}^*_{p,t} = y_t + r(b^*_{p,t} + E_{0,t}) - c_t - \dot{E}_{0,t}. \tag{4.43}$$

The above equation states that the home agent's net foreign assets holdings increase if his income, that is, production and interest income, exceeds consumption, or if he sells (part of) his endowment to buy foreign bonds.

First, it will be derived how foreign assets held by the domestic agent evolve during period $[0, T^{**}]$, that is, before capital inflows cease. During this interval, central bank reserves are constant at their initial level $b^*_{CB,0} \equiv E_0$. Thus, the change in private net foreign assets is given by

$$\dot{b}^*_{p,t} = y_I - c_I + r(b^*_{p,t} + b^*_{CB,0}) \tag{4.44}$$

where y_I, and c_I denote period output and consumption during the stabilization interval. The international borrowing constraint is defined in terms of the *level* of private net foreign assets. In order to derive if and when the borrowing constraint will be binding, above differential equation is solved for $b^*_{p,t}$. The solution of a differential equation is generally given as the sum of the solution to the homogenous equation (the *complementary solution*) and so-called *particular solution*, that is, one possible solution for the entire differential equation.[18] In a first step, the solution of the homogenous equation is derived. Solving the differential equation

$$\dot{b}^*_{p,t} - rb^*_{p,t} = 0$$

yields the complementary solution as

$$b^*_{p,t}(c) = Ae^{rt}$$

where A denotes an undefined constant.

The *particular solution* for $\dot{b}^*_{p,t} = 0$ yields $b^*_{p,t}(p)$ as

$$b^*_{p,t}(p) = r^{-1}(-y_I + c_I) - b^*_{CB,0}.$$

[18] See for example Sydsaeter et al. (1999:62ff).

The *general solution* is the sum of the complementary and the particular solution:

$$b^*_{p,t} = b^*_{p,t}(c) + b^*_{p,t}(p) = Ae^{rt} + r^{-1}(-y_I + c_I) - b^*_{CB,0} \tag{4.45}$$

In a next step, the value of the constant A can be determined by solving above equation for a specific period. For $t = 0$, above equation yields

$$0 = A + r^{-1}\left[-y_I + c_I - rb^*_{CB,0}\right]$$

where I have used the fact that the private sector does not dispose of initial foreign assets, that is, $b^*_{p,0} = 0$.

This can be solved for A to yield

$$A = r^{-1}(y_I - c_I + rb_{p,0})$$

Thus, as long as the domestic economy receives net capital inflows, that is, during periods 0 to T^{**}, private sector net foreign assets are given as

$$\begin{aligned} b^*_{p,t} &= r^{-1}(y_I - c_I + rE_0)e^{rt} + r^{-1}(-y_I + c_I - rE_0) = \\ &= r^{-1}\left[(y_I - c_I + rE_0)\right]\left(e^{rt} - 1\right) \\ &= \int_{s=0}^{t}(y_I + rE_0 - c_I)e^{rs}dt \end{aligned}$$

where I have used the assumption that $b^*_{CB} \equiv E_0$. The above equation is identical to equation (4.36) used in the body of this chapter.

During periods T^{**} to T^*, the current account deficit can no longer be financed with capital inflows. Demand for foreign goods – and foreign currency – thus effects a depletion of central bank foreign currency reserves. Their dynamics can be formulated as follows:

$$\dot{b}^*_{CB,t} = \dot{E}_{0,t} = y_I - c_I + r(b^*_{CB,t} + \tilde{b}^*_{p,T^{**}}). \tag{4.46}$$

Note that $y_I - c_I + r(b^*_{CB,t} + \tilde{b}^*_{p,T^{**}})$ is negative, since both $\tilde{b}^*_{p,T^{**}}$ and $(y_I - c_I + rb^*_{CB,t})$ are smaller than zero. Solving this differential equation for the level of central bank reserves I proceed as above: The *complementary solution* of the homogenous equation is

$$b^*_{CB,t}(c) = Be^{rt},$$

where B denotes an undefined constant.

A *particular solution* (for $\dot{b}_{CB,t} = 0$) is

$$b^*_{CB,t}(p) = r^{-1}\left(c_I - y_I - r\tilde{b}^*_{T^{**}}\right).$$

This yields the *general solution* as

$$b^*_{CB,t} = b^*_{CB,t}(c) + b^*_{CB,t}(p) = Be^{rt} + r^{-1}\left(c_I - y_I - r\tilde{b}^*_{T^{**}}\right). \qquad (4.47)$$

The value of B can be derived by solving above equation for $t = T^{**}$. As the central bank did not intervene in the foreign exchange market up to period T^{**}, its reserves are at their initial level, that is, $b^*_{CB,T^{**}} = b^*_{CB,0}$.

$$b^*_{CB,T^{**}} = b^*_{CB,0} = Be^{rT^{**}} + r^{-1}\left(c_I - y_I - r\tilde{b}^*_{T^{**}}\right).$$

This yields B as

$$B = \left[b^*_{CB,0} - r^{-1}\left(c_I - y_I - r\tilde{b}^*_{T^{**}}\right)\right] e^{-rT^{**}}.$$

Substituting above expression for B into the general solution yields

$$\begin{aligned} b^*_{CB,T} &= b^*_{CB,0}e^{r(T-T^{**})} + r^{-1}\left(y_I - c_I + r\tilde{b}^*_{T^{**}}\right)\left(e^{r(T-T^{**})} - 1\right) \\ &= b^*_{CB,0}e^{r(T-T^{**})} + \int_{t=T^{**}}^{T} (y_I - c_I + r\tilde{b}^*_{T^{**}})e^{r(t-T^{**})}dt \\ &= \left[b^*_{CB,0} + \int_{t=T^{**}}^{T} (y_I - c_I + r\tilde{b}^*_{T^{**}})e^{r(t-T)}dt\right] e^{r(T-T^{**})} \end{aligned}$$

for $T \in \{T^{**}, T^*\}$, which is the equation (4.37) used in the body of this chapter.

4.7.3 Parameter Values for which Stabilization-Period Consumption Exceeds Stabilization-Period Output

Reformulating the first-order conditions (4.13) and (4.14), the ratio of period consumption and output during the stabilization-interval can be expressed as

$$\frac{c_I}{y_I} = \left(\frac{1 + \alpha(r + \varepsilon^e_{II})}{1 + \alpha r}\right)^{\sigma} \left(\frac{1 - \nu(r + \varepsilon^e_{II})}{1 - \nu r}\right) \frac{c_{II}}{y_{II}}. \qquad (4.48)$$

$\frac{c_I}{y_I}$ exceeds $\frac{c_{II}}{y_{II}}$ if $\left(\frac{1+\alpha(r+\varepsilon^e_{II})}{1+\alpha r}\right)^{\sigma}\left(\frac{1-\nu(r+\varepsilon^e_{II})}{1-\nu r}\right) > 1$. *Assumption 1* states: *α, ν, σ, r, and ε^e_{II} are such that* $\left(\frac{1+\alpha(r+\varepsilon^e_{II})}{1+\alpha r}\right)^{\sigma} > \frac{1-\nu r}{1-\nu(r+\varepsilon^e_{II})}$.

One set of realistic parameter values for which above inequality holds is $\alpha = 0.7$, $\nu = 0.3$, $\sigma = 0.6$, $r = 0.04$ and $i^e_{II} = 40$ %. Recall that α is the fraction of consumer spending covered with cash, ν the fraction of output, and r the real interest rate. σ denotes the agent's intertemporal elasticity of substitution, $\sigma = -\frac{\partial u/\partial c}{\partial^2 u/\partial^2 c} = -\frac{\partial u/\partial c}{\partial(\partial u/\partial c)} : \frac{c}{\partial c}$. Empirical estimates for σ based on Latin American data yield values in a range from -0.017 to 2.87 (see Reinhart and Végh, 1995a:366, and Agenór and Montiel, 1996:353); recent estimates for industrial countries incorporating durable goods (Reinhard and Ogaki, 1998) and households' asset market participation (Vissing-Jorgensen, 2002) suggest that intertemporal elasticities of substitution are larger than found previously. Therefore, the (relatively high) value of 0.6 was assumed. Assuming an expected devaluation of 40 percent is in line with the magnitude of devaluations witnessed after stabilization.

Chapter 5

Concluding Remarks

This dissertation has explored empirical and theoretical aspects of ERBS in developing economies. An assessment of the stylized facts of ERBS evinces that these are typically accompanied by an initial boom in consumption and output, a real appreciation, a current account deterioration, and portfolio investment inflows. A decomposition of the Brazilian-US real exchange rate reveals that exchange rate-adjusted prices of tradable goods and relative prices of non-tradables in Brazil are of roughly equal importance for the real appreciation.

The models developed in this dissertation emphasize that stabilizations frequently lack credibility, and show how this engenders the observed real and monetary dynamics: The real exchange rate appreciation during ERBS is explained with forward-looking price setting during non-credible, transitory stabilization. Furthermore, it is demonstrated that a stabilization's collapse can result from self-fulfilling expectations about its duration.

My research casts doubt on the effectiveness of ERBS: The empirical evidence indicates that– contrary to what is commonly believed and modeled– even relatively successful and long-lived exchange rate pegs are associated with a late slowdown in consumption and output growth, as well as an only temporary reduction in unemployment. More importantly, my study reveals that rather few ERBS are successful. Why is that so? The answer suggested here is that ERBS frequently lack credibility. This lack of credibility can give rise to a consumption boom, current account deficits and foreign debt: A self-fulfilling currency crisis is the result. I find the accumulation of foreign debt the most troubling stylized fact of ERBS. It can potentially culminate in the country's default, locking it out from international credit markets for a prolonged period. In terms of lost output growth, this is particularly painful for developing economies with typically low saving rates.

If, in contrast, MBS is non-credible, agents' holdings of domestic currency increase by less and the devaluation rate falls by less than during credible stabilization. The recessionary impulse resulting from the associated further contraction in real money balances counteracts a possible temporary demand increase, which might occur as agents expect future inflation rate increases. Thus, during MBS current account deficits and foreign debt increase by less than during ERBS.

What consequences are to be drawn from the susceptibility of ERBS to (self-fulfilling) currency crises? One wisdom which is increasingly becoming consensus among economists is that the 'middle ground' of exchange rate arrangements is to be avoided: Developing countries should either float or irrevocably peg their exchange rates. Therefore, currency boards were hailed as a panacea for inflationary economies. As currency boards fell out of grace due to the recent Argentinean crisis, disciples of the above wisdom now praise dollarization. This neglects that, similarly to a currency board, dollarization is just a *promise* to permanently replace the national currency with the US dollar. Promises, however, can be broken – a government can decide to re-introduce a national currency, for example by remunerating government employees with the newly printed currency and by restricting the withdrawal of dollars. As the Argentinean experience shows, such a scenario is not too far off: Recently, the government of La Rioja, one of Argentina's 24 provinces, started issuing a provincial bond which is being used as a local currency. If a currency board or dollarization is reversed, the loss of confidence of both the domestic population and international investors is likely to leave a severely wounded economy. Thus, fixing ever more might be the fix: Pegging or dollarizing without the certitude that the necessary conditions for the arrangement's medium to *long run* sustainability can be met– and be met also in the presence of external shocks and political changes– is dangerous. This certitude, however, can only exist for countries whose governments have already achieved credibility and stability by implementing and maintaining stabilization-oriented policies. The surprising conclusion would thus be that only those countries meet the requirements for a hard peg or dollarization which do not need it. Governments desperately longing for a boost of credibility through dollarization, in contrast, would have to stay away from it.

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Selbständigkeitserklärung

Hiermit erkläre ich, die vorliegende Arbeit selbständig ohne fremde Hilfe verfaßt und nur die angegebene Literatur und Hilfsmittel verwendet zu haben.

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24. Juli 2002